FR65-14-277

FINAL REPORT
FOR
DSIF S-BAND CASSEGRAIN CONE ASSEMBLY
FOR A 30-FOOT ANTENNA
(13 JANUARY 1965 – 23 SEPTEMBER 1965)

CONTRACT NO.: 951127

PREPARED BY
HUGHES AIRCRAFT COMPANY
GROUND SYSTEMS GROUP
FULLERTON, CALIFORNIA

FOR
JET PROPULSION LABORATORY
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PASADENA, CALIFORNIA

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ABSTRACT

N66-22944

This final report provides a brief history and technical information concerning the design, fabrication, test, and field handling of the S-Band Cassegrain Monopulse (SCM-30) Cone Assembly for the DSIF 30-ft-diameter antenna. The report includes the following elements: physical description of all major R. F. and support structure components used on the SCM-30 Cone Assembly; installation and alignment procedures for the assembly; a summary of the stress and vibration analysis; electrical and mechanical test procedures for Feeds and SCM-30 Cone Assemblies, and data recorded during the tests of the two feeds and two assemblies.

The results of the electrical and mechanical tests and the stress and vibration analysis indicate that the two SCM-30 Cone Assemblies are electrically and mechanically sound in both design and fabrication and therefore will satisfy all specified preformance requirements.

The non-investigative and passive nature of the SCM-30 Cone Assembly program precludes specific conclusions or recommendations. Only a general recommendation can be made: the success of the present program permits SCM-30 Cone Assemblies required in the future to be produced as duplicates of the SCM-30 Cone Assemblies already delivered to JPL.

Author

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Section One
INTRODUCTION

Section One

1. INTRODUCTION

1.1 Scope and Purpose of Report. This final report documents the design of an S-Band Cassegrain Monopulse Cone Assembly for a DSIF 30-ft-diameter antenna (SCM-30 Cone Assembly), and documents the subsequent fabrication, test, and preparation for shipment of two SCM-30 Cone Assemblies. The work, which was begun on 13 January 1965 and was completed on 23 September 1965, was performed by Hughes Aircraft Company for Jet Propulsion Laboratory under JPL Contract No. 951124. This report is submitted to satisfy the requirements of paragraph (a)(6)(ii) of JPL Statement of Work No. 332-SW-314 (Ref. 1).

1.2 General Background of the Project. For many years Hughes has designed and produced radar systems and assemblies. Starting in 1963, Hughes designed and fabricated the SCM Cone Assemblies for DSIF 85-ft-diameter antennas (Ref. 8), and delivered the last of seven required cone assemblies on 27 January 1965. Later in 1964 when JPL solicited proposals for the SCM-30 Cone Assemblies, Hughes was selected to perform the work, much of which was based on the earlier design.

1.3 Breakdown of SCM-30 Cone Assembly into Component Parts. The SCM-30 Cone Assembly, J9431331, is composed of the cone structure, an SCM feed, a feed mounting structure, interconnecting waveguides, waveguide switches, loads, coax-to-waveguide transitions and mounting hardware. The completed SCM-30 Cone Assembly is shown in Figure 1. It weighs approximately 820 pounds and is 86.08 inches long, 50.00 inches in diameter at the base, and 12.25 inches square at the top of the radome cover.

1.4 Summary of Work Performed and Major Accomplishments

1.4.1 The design and fabrication of the SCM-30 Cone Assembly started on 13 January 1965. The work was performed in four stages: (1) feed electrical design, (2) component layout design, (3) fabrication drawing preparation, and (4) fabrication, assembly and test.

1.4.2 During the first phase, the existing JPL feed design used on the SCM-85 Cone Assembly was modified to meet new JPL specification requirements (Ref. 2 and 3).

1.4.3 During the second phase the primary effort was to arrange the R. F. components in proper relation to each other and to the Cassegrain cone. The preliminary layout design was approved by JPL on 2 March 1965 (Ref. 4). Following this approval, and at JPL request, some minor changes were incorporated in the final layout design. These changes were approved by JPL on 10 March 1965 (Ref. 5).

1.4.4 The effort during the third phase was to prepare the drawings for fabrication. This included (1) the preliminary detail design of R. F. components consisting of revised and new feed and waveguide runs, and (2) the support structure components consisting of three-section cone, rail-mounting assemblies and brackets. Feed drawings were released for fabrication first, followed by those for the support structure and finally for the waveguide runs.

1.4.5 During the fourth phase the individual components were made and systems were assembled, tested, and prepared for shipment.

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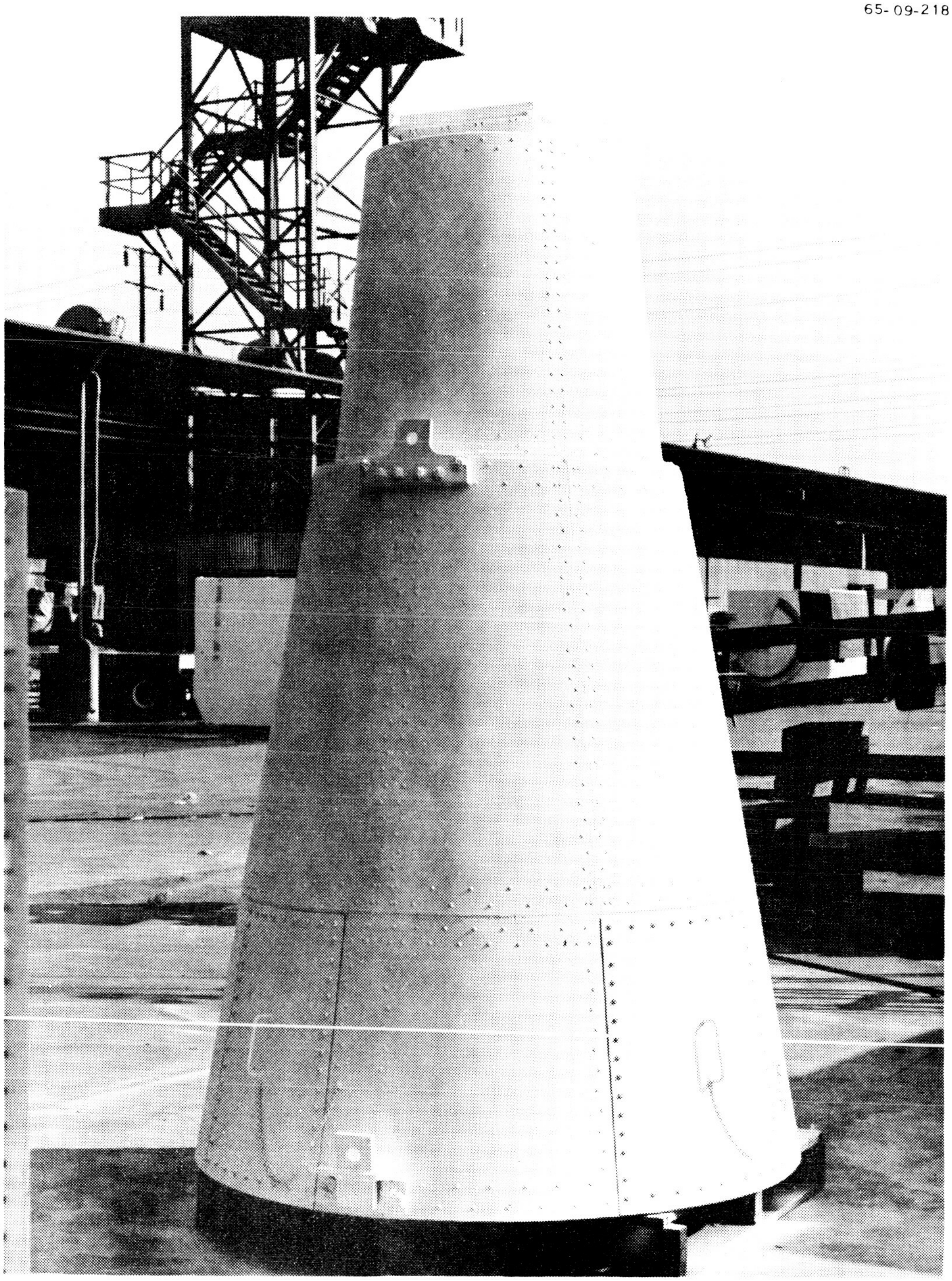

Figure 1. SCM-30 Cone Assembly J9431331

Section Two
TECHNICAL DISCUSSION

Section Two

2. TECHNICAL DISCUSSION

2.1 EQUIPMENT PERFORMANCE CHARACTERISTICS

2.1.1 The feed system for the SCM-30 antenna is a multimode, dual frequency, dual plane monopulse feed mounted in a Cassegrain cone assembly. The feed consists of a conventional dual polarization, dual plane monopulse hybrid network feeding a common waveguide multimode horn, similar to that described in the literature (Ref. 6). No shaping of the sum pattern is done. As the theory of multimode feeds is well known, it will not be repeated here. A feed similar to the SCM-30 feed has also been previously developed for JPL for use as an S-Band Acquisition Antenna for the 85-foot antennas (Ref. 7).

2.1.2 The performance of each feed system is given in detail in Appendices III and IV; however, typical performance characteristics are also provided here.

2.1.3 The sum patterns of the feed provide a 48 degree 11.5 db beamwidth at 2285 Mc, with a 26 db sidelobe level. The axial ratio is typically 0.8 db at 2285 Mc and at 2110 Mc. Variation of axial ratio in the frequency bands 2285 ±15 Mc and 2110 ±10 Mc is about 0.3 db.

2.1.4 The peak-to-peak separation of the difference pattern is about 38 degrees with a sidelobe level of about 17 db. The difference pattern null depth is typically 35 db or greater. The boresight roll error versus incident linear polarization is less than 0.23 degree on both feeds. Null plane orthogonality is about 89.0 degrees. Boresight agreement between left and right circular polarization is less than 0.12 degree.

2.1.5 The isolation of the reference (sum) port of the monopulse bridge to all other ports is greater than 30 db and in most cases greater than 40 db, resulting in a noise temperature contribution to the sum channel of about 1.0° Kelvin. The insertion loss of the bridge is about 0.05 db. Difference channel intercoupling is better than 30 db.

2.1.6 The VSWR of each sum port is typically less than 1.10 at 2110 ±10 Mc and 2285 ±15 Mc. The error channel port VSWR is less than 1.2 over the frequency band 2290 ±10 Mc.

2.1.7 The spillover efficiency of the feed used in a Cassegrain system with a 48-degree subtended feed angle is greater than 87.0 percent.

2.2 COMPONENTS

2.2.1 The SCM-30 Cone Assembly consists of JPL-furnished components and HAC-designed and fabricated components. JPL-furnished components are listed in Table 1 and illustrated in Figures 2 through 4.

Table 1. JPL-Furnished Components

Part No.	Drawing No.	Name	Qty.	Figure
Maury Microwave Model L-174	D 9334996	7/8 Coax-to-Waveguide Transition	4	2
Rantec Model LS-102	B 9335879	Load	8	3
Ramcor RAM 256	D 9335900	Switch Assembly	6	4

2.2.2 Table 2 lists the major HAC-designed and fabricated components, which are discussed in the following paragraphs. These major components are illustrated individually in Figures 5 through 14. The complete list of HAC-designed and fabricated components is contained in Appendix I.

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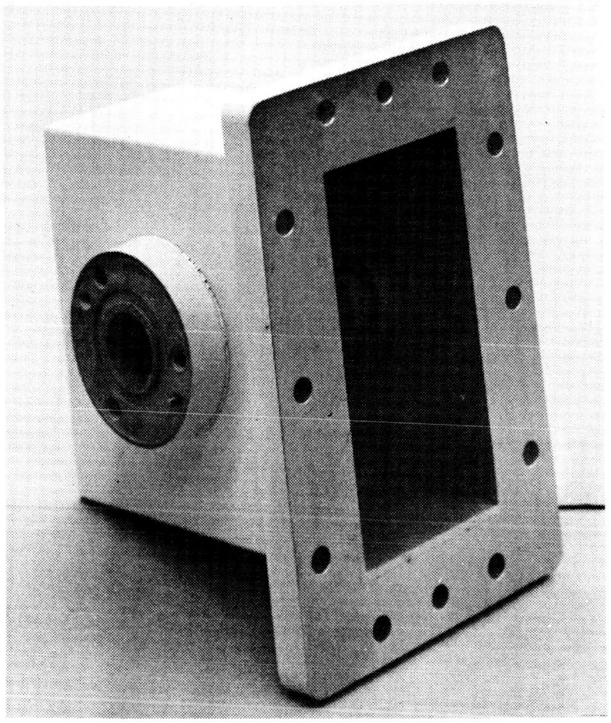

Figure 2. 7/8 Coax to Waveguide Transition, D9334996

64-06-010

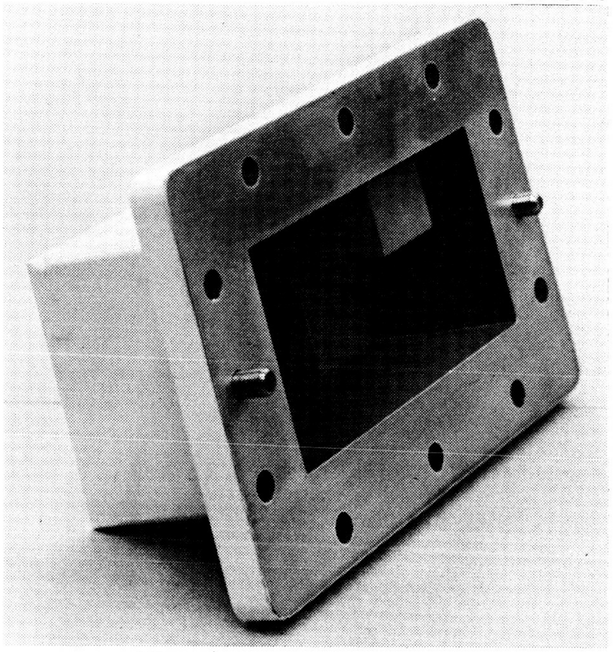

Figure 3. Load, B9335879

64-04-248

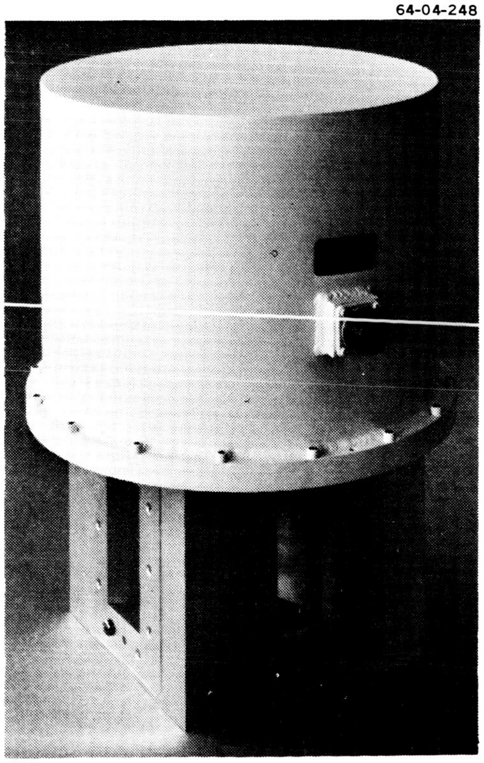

Figure 4. Switch Assembly, D9335900

Table 2. Major HAC-Designed and Furnished Components

Item	Part No.	Name	Figure
1	J9431332	Feed Assembly	5
2	D9335143	Waveguide Run, Double Elbow	6
3	J9335146	Waveguide Run, 90^{o} Elbow	6
4	J9335148	Waveguide Run, 90^{o} Elbow	6
5	D9431335	Waveguide Run, Joggle Section	6
6	D9431339	Waveguide Run, Double Elbow	6
7	D9431372	Radome Cover	7
8	J9431342	Cassegrain Cone	8 & 9
9	D9431359	Rail-Mounting, Feed	10
10	D9431373	Rail-Mounting, Feed	10
11	D9431375	Rail-Mounting, Feed	10
12	D9432646	Bracket Mounting, SW-No. 1	11
13	J9432640	Bracket Mounting, SW-No. 2	12
14	J9432658	Bracket Support	12
15	J9432641	Bracket Mounting, SW-No. 3	13
16	C9432656	Bracket Angle	--
17	C9432657	Plate Support	--
18	D9432659	Bracket Support, Waveguide	14
19	C9432653	Bracket Support, Waveguide	14
20	C9432651	Bracket Support, Waveguide	14
21	C9432650	Bracket Support, Waveguide	14
22	D9335198	Clamp, Waveguide	14
23	C9432649	Bracket Support, Waveguide	14

2.2.3 Feed Assembly — The Feed Assembly, J9431332, is made up of one feed consisting of twelve brazed components and one radome, and two sets of feed support adapter assemblies. The feed components are listed in Table 3, and illustrated in Figures 15 through 27. An exploded view of the feed components is shown in Figure 27.

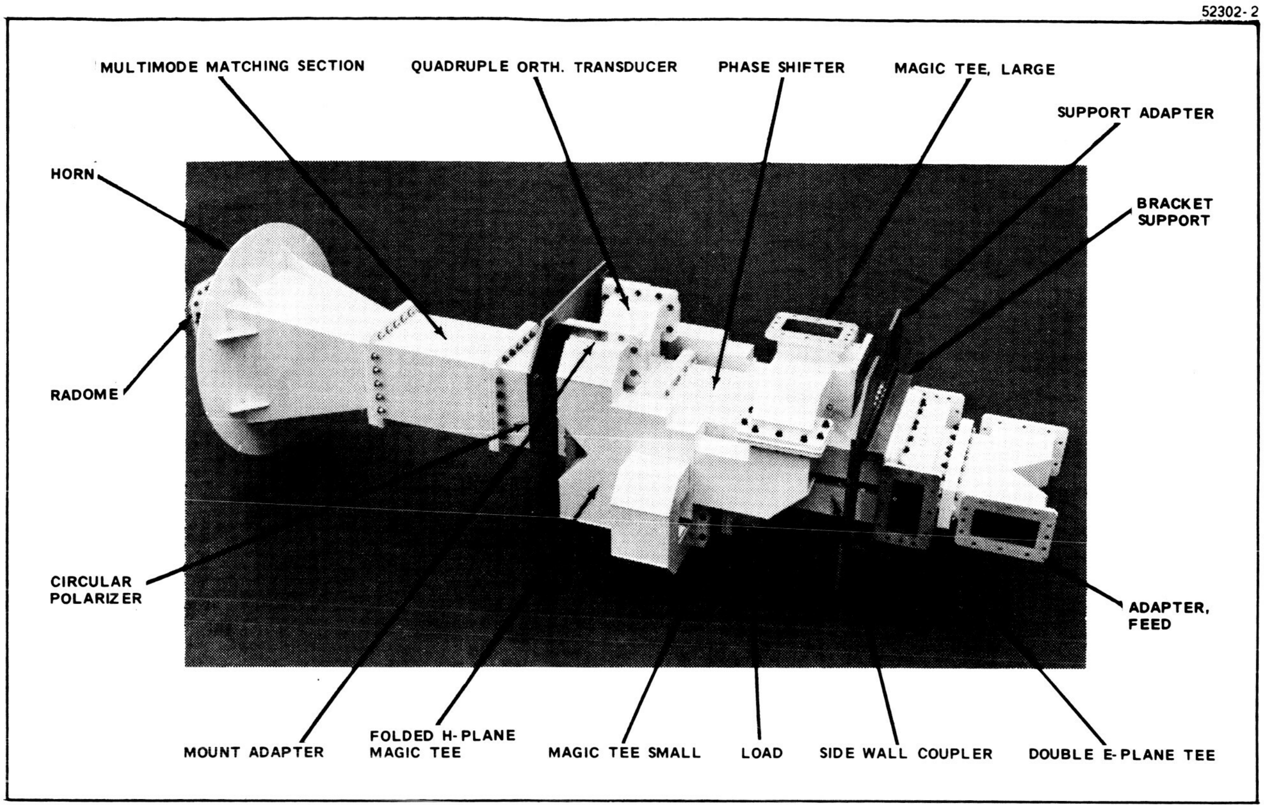

Figure 5. Feed Assembly, J9431332

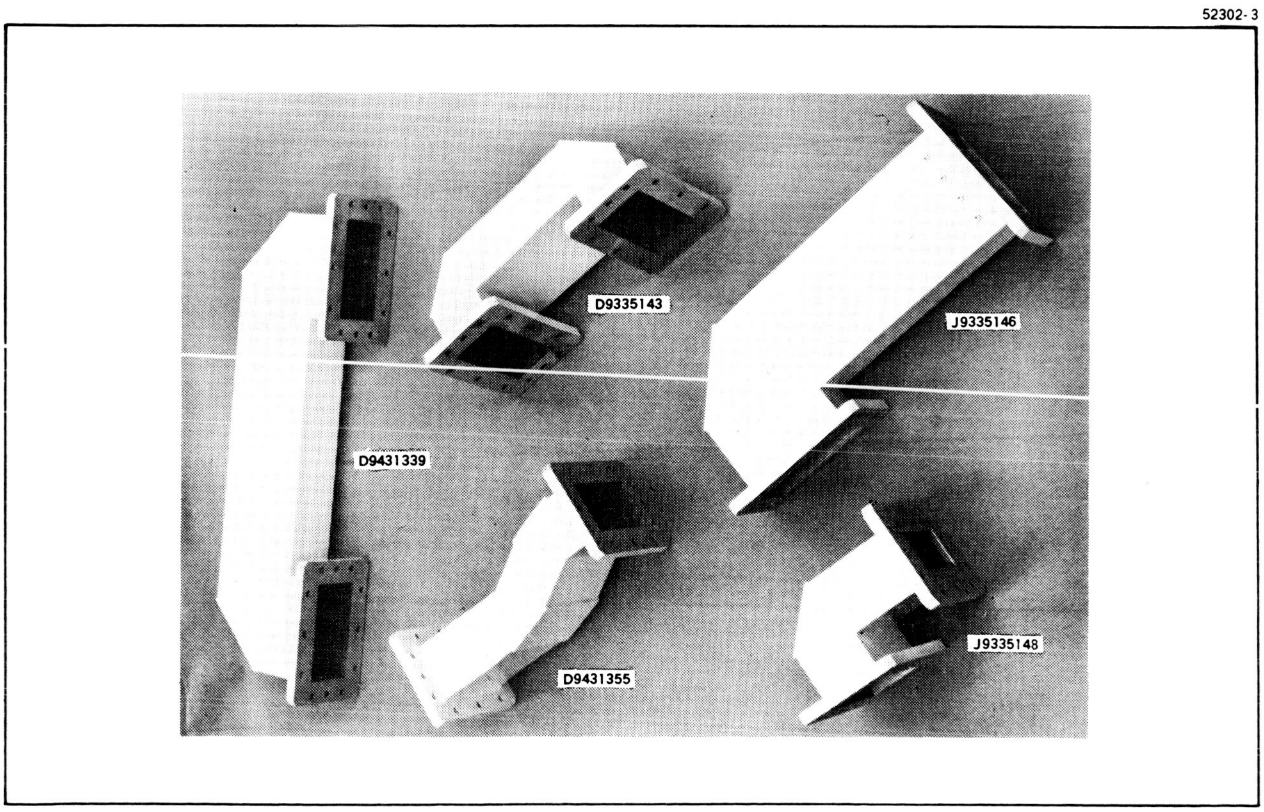

Figure 6. Waveguide Runs

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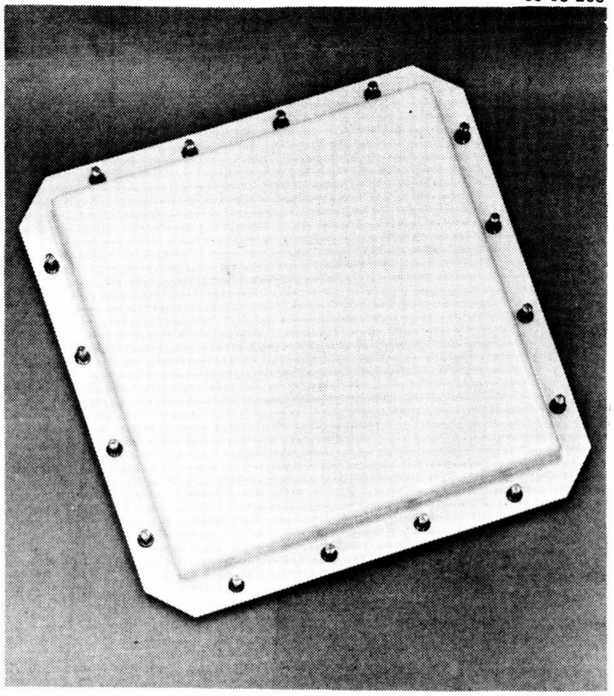

Figure 7. Radome Cover, D9431372

65-06-297

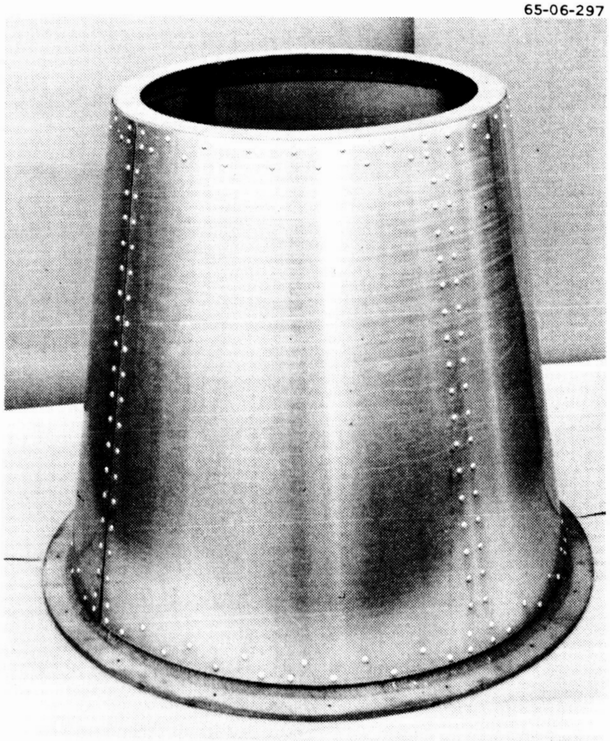

Figure 8. Cassegrain Cone, Upper Section, J9431342

65-08-278

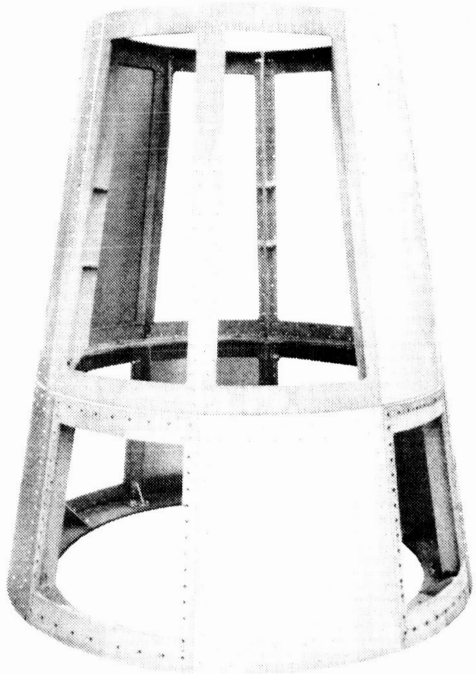

Figure 9. Cassegrain Cone, Center and Lower Sections

65-08-206

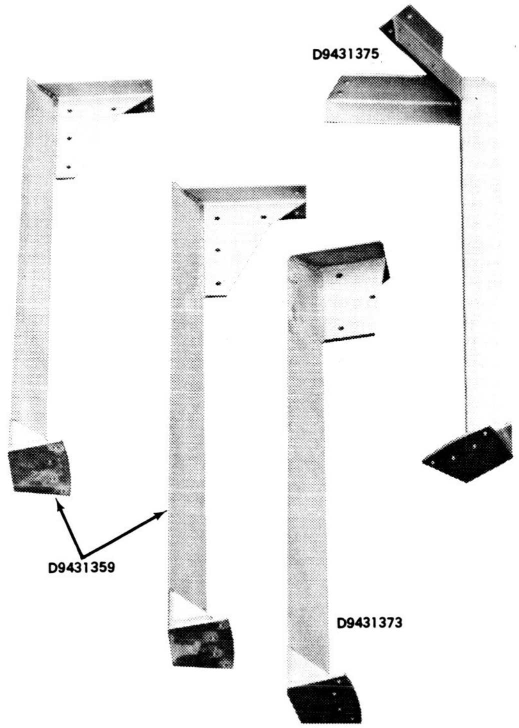

Figure 10. Rail Mounting, Feed

65-08-366

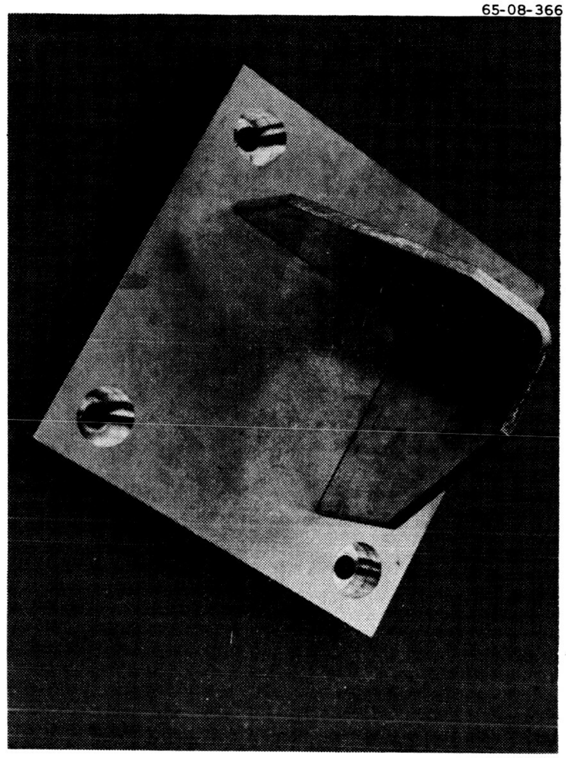

Figure 11. Bracket Mounting, SW. No. 1, D9432646

52302-6

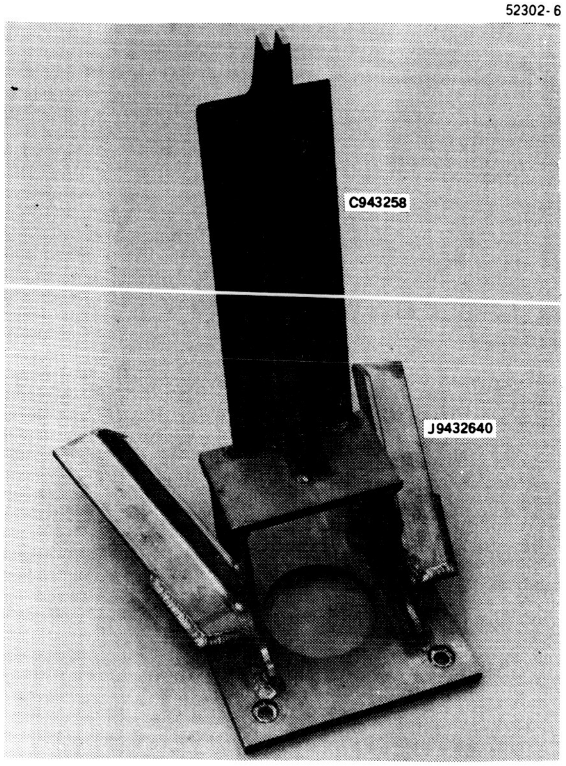

Figure 12. Bracket Mounting and Bracket Support, SW. No. 2

65-08-363

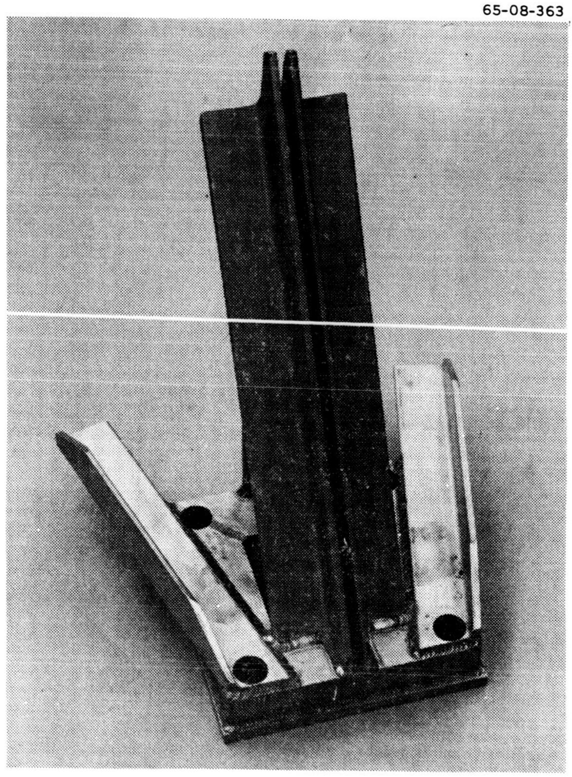

Figure 13. Bracket Mounting, SW. No. 3, J9432641

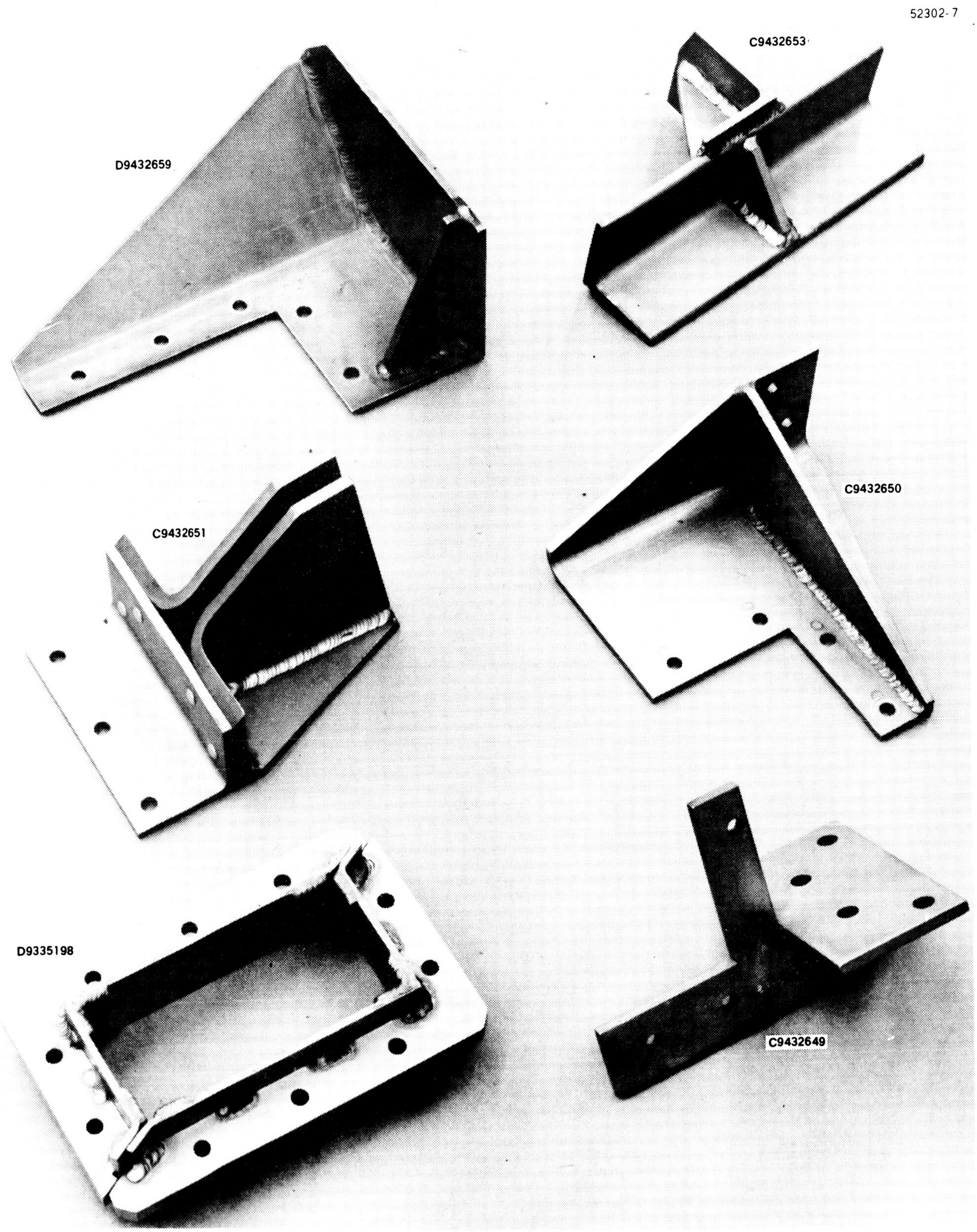

Figure 14. Support Brackets, Waveguide Runs

52302-4

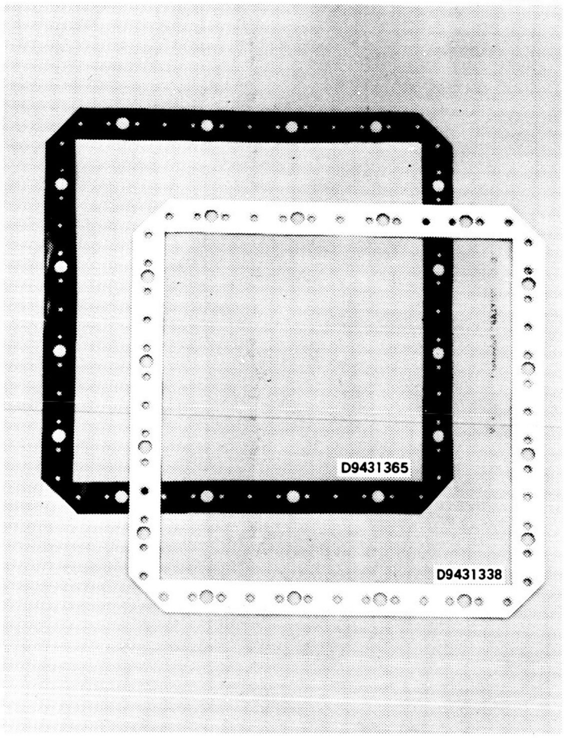

Figure 15. Radome and Horn Gasket

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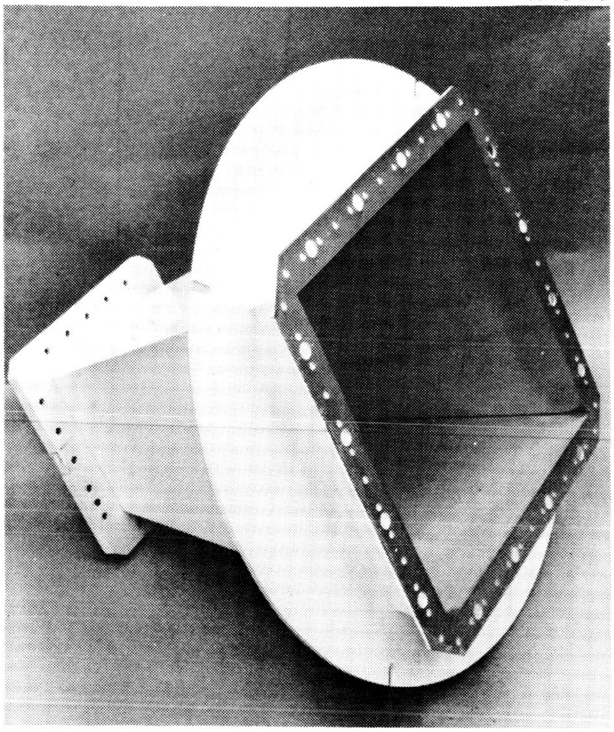

Figure 16. Horn, J9431337

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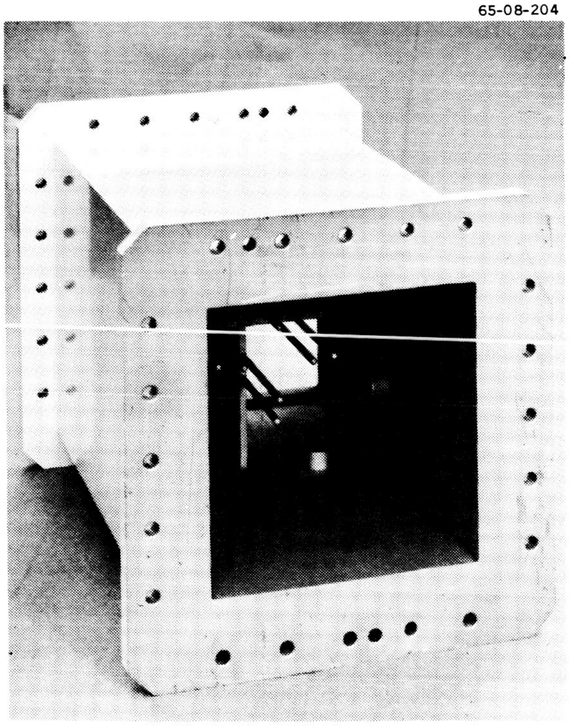

Figure 17. Multimode Matching Section, J9431336

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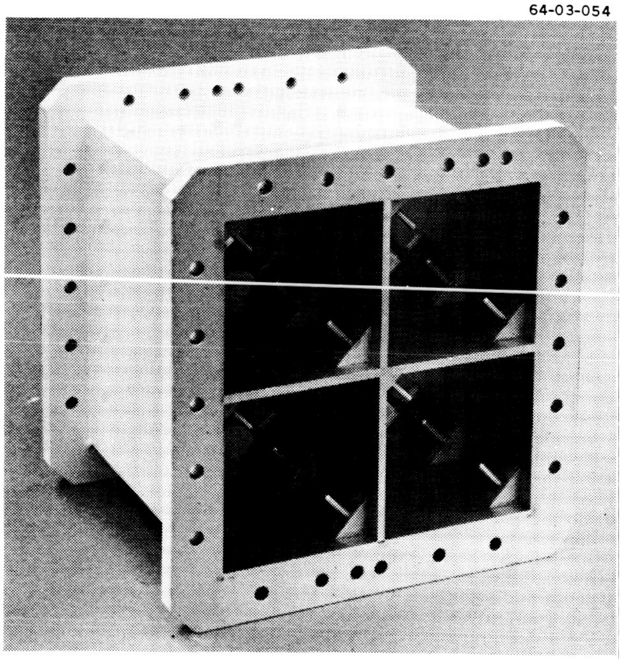

Figure 18. Circular Polarizer, D9335068

64-03-045

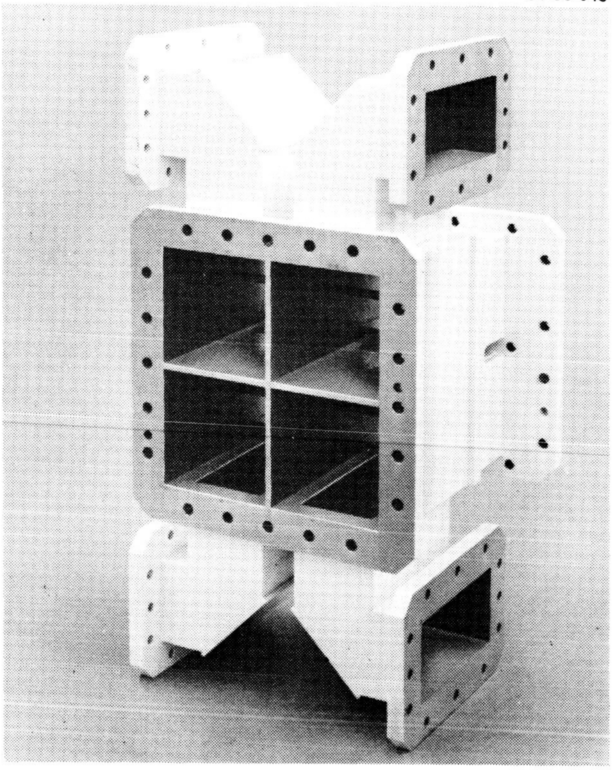

Figure 19. Quadruple Orthomode Transducer, J9335036

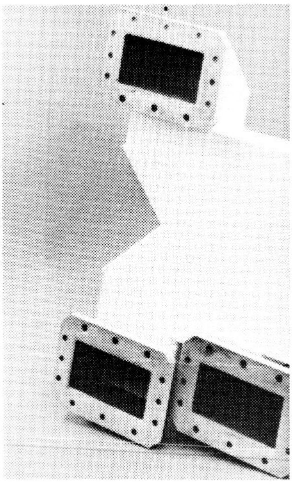

Figure 20. Folde
J9335

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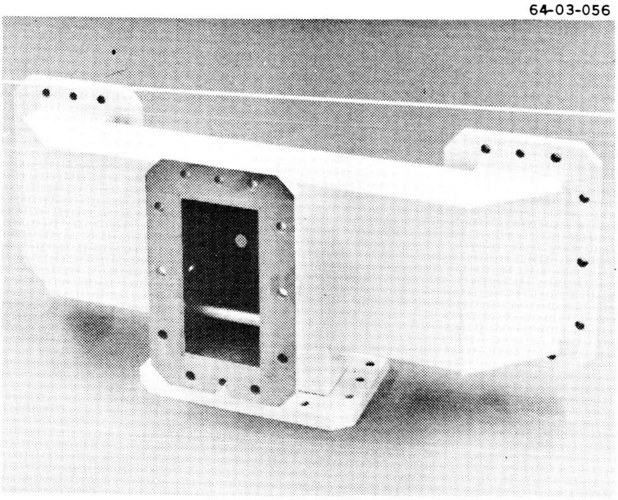

Figure 21. Magic Tee, Large, D9335076

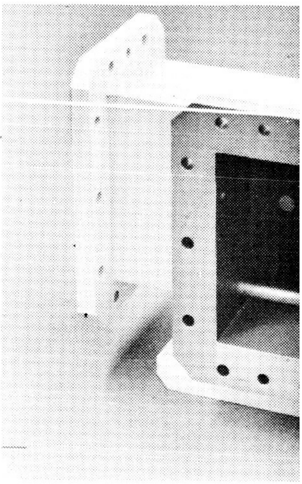

Figure 22. Magic T

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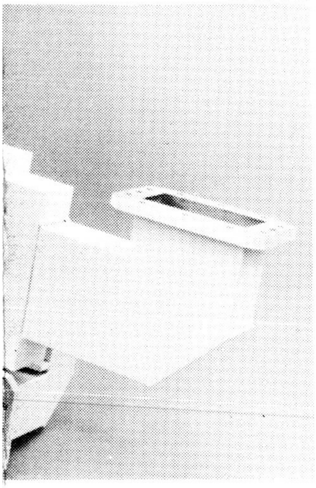

d H-Plane Magic Tee,
050-1

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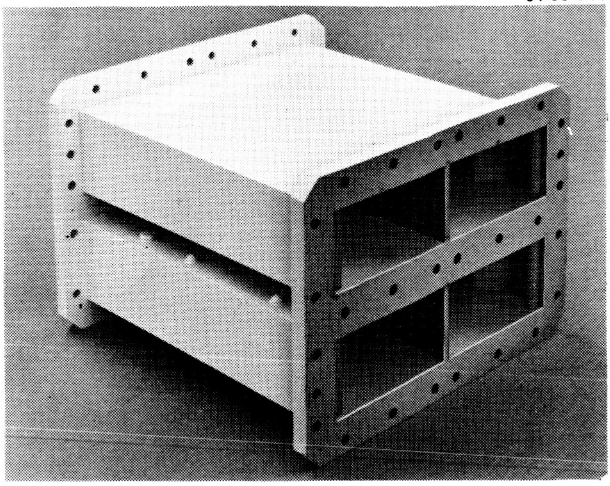

Figure 23. Side Wall Coupler, J9431334

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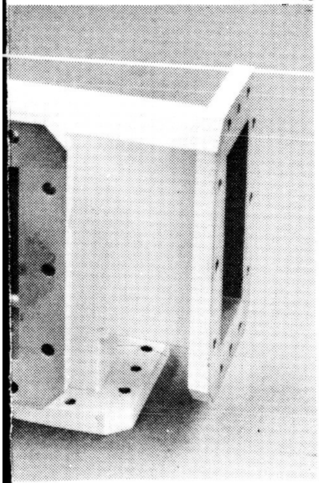


ee, Small, J9335129

64-03-038

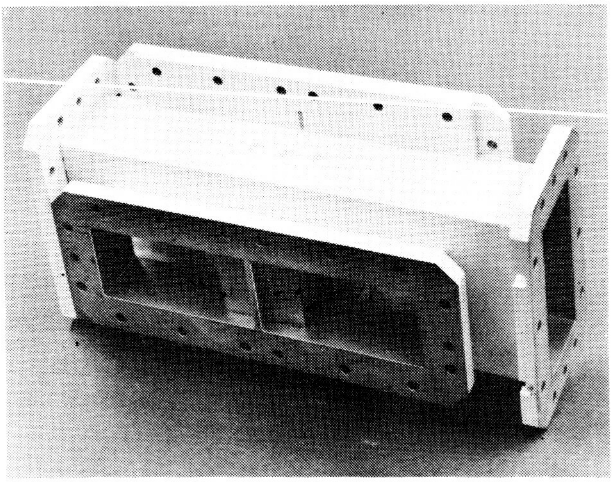


Figure 25. Double E- Plane, Magic Tee, J9335115

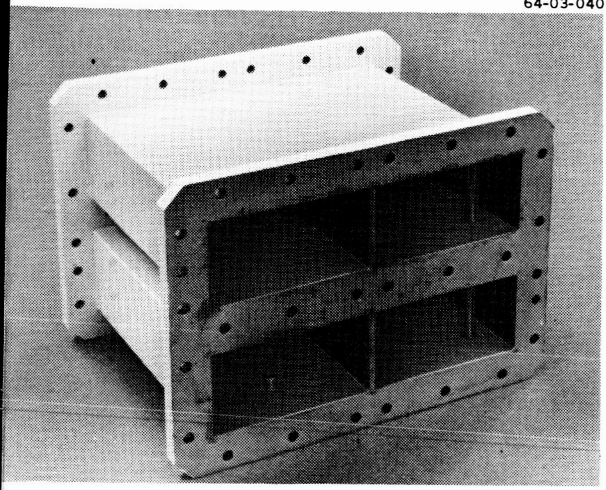


Figure 24. Phase Shifter, J9431335

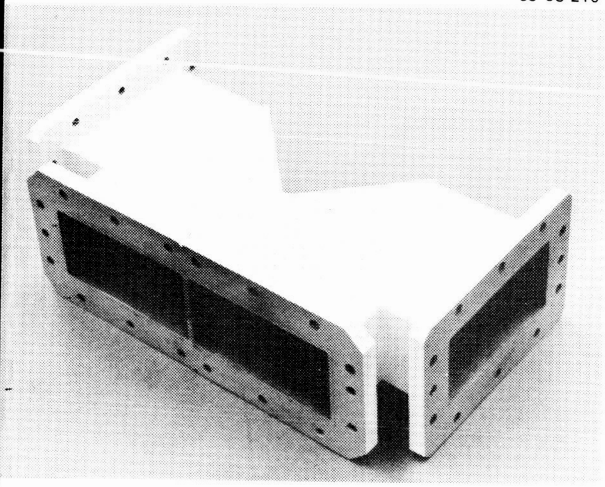
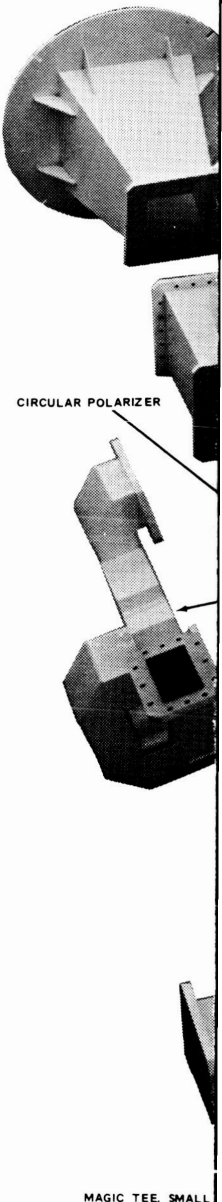


Figure 26. Adapter Feed, J9431333



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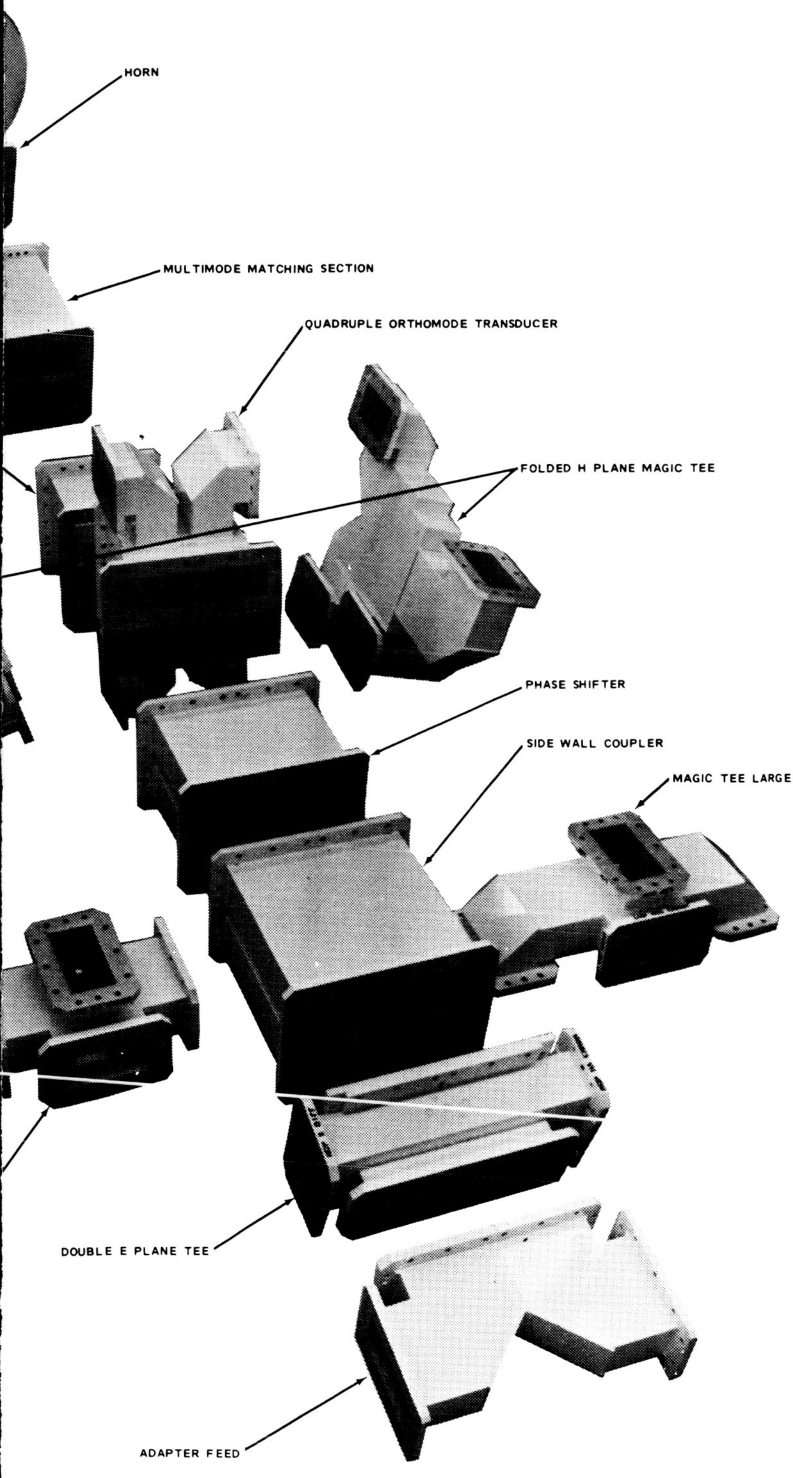

gure 27. Feed Components, Exploded View

5

Table 3. Feed Components

Item	Part No.	Name	Figure
1	D9431338	Radome	15
2	D9431365	Gasket-Horn	15
3	J9431337	Horn	16
4	J9431336	Multimode Matching Section	17
5	D9335068	Circular Polarizer	18
6	J9335036	Quadruple Orthomode Transducer	19
7	J9335050-1	Folded H-Plane Magic Tee	20
8	J9335050-2	Folded H-Plane Magic Tee	--
9	D9335076	Magic Tee, Large	21
10	J9335129	Magic Tee, Small	22
11	J9431334	Side Wall Coupler	23
12	J9431335	Phase Shifter	24
13	J9335115	Double E-Plane Tee	25
14	J9431333	Adapter, Feed	26

2.2.4 Most of the feed components are the same as used on SCM-85 Cone Assembly, J9335016. The new components are Radome, Horn, Multimode Matching Section, Phase Shifter, Side Wall Coupler, and Feed Adapter.

2.2.5 The Radome, D9431338, is a two-piece component made from non-crazing Type W-2 Mylar film 0.005 inch thick, suitably bonded to the .125 aluminum ring, through which it is mounted to the front aperture of the horn. Its function is to prevent dust or other foreign particles from entering into the system. In addition, when the SCM-30 Cone Assembly is pressurized with dry nitrogen, the Radome closes the pressure system. During shipping and during intervals of non-operation of the SCM-30 Cone Assembly the Radome is protected with the aluminum alloy Radome Cover, D9431372.

2.2.6 The Horn, J9431337, is 15.00 inches long, with 12.000-inches-square front aperture and 5.400-inches-square throat. It weighs approximately 16 pounds. The Horn fabrication is changed (as compared with that used on the SCM-85 Cone Assembly) from riveting to brazing method. This reduces the nitrogen leakage rate of the system. The horn phase center is 81.578 inches from the vertex of the reflector.

2.2.7 The Multimode Matching Section J9431336 provides matching of the fields from the waveguide bridge into the monopulse horn. Also it provides phase correction for the difference modes to ensure the radiated error channel patterns are circularly polarized. It is 11.65 inches long with a 5.400 inch square front aperture. It weighs approximately 13.5 pounds.

2.2.8 The Phase Shifter, J9431335, and the Side Wall Coupler, J9431334, are essentially the same as J9335092 and J9335085 respectively (used on the SCM-85 Cone Assembly). The length of the Phase Shifter is increased from 8.240 inches to 9.225 inches, while the length of the Side Wall Coupler decreased from 10.500 inches to 9.500 inches. Together for the two, the overall length decreased by 0.015 inches. The Phase Shifter weighs approximately 9.00 pounds; the Side Wall Coupler, 15.50 pounds.

2.2.9 The Adapter Feed, J9431333, consists of two identical and symmetrical H-Plane 90° Elbows held together with a standard Flange D9335117. It weighs approximately 5.00 pounds.

2.2.10 The present Feed is provided with two sets of support adapters and appropriate brackets. One set is mounted to the four elbow flanges of the Quadruple Orthomode Transducer, and the second to the double flange of the Side Wall Coupler interfacing with Double E-Plane Magic Tee. Their functions are:

1. To facilitate the handling of the feed.
2. To bridge the feed to the cone support structure.
3. To enable the alignment of the feed centerline with that of the Cassegrain Cone.

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1. To facilitate the handling of the feed.
2. To bridge the feed to the cone support structure.
3. To enable the alignment of the feed centerline with that of the Cassegrain Cone.

2.2.11 Waveguide Runs – The SCM-30 Cone Assembly consists of fourteen waveguide runs. Their distribution is as follows:

- Sum Channel – Four waveguide runs connecting RCP Sum and LCP Sum feed ports to the Switch Assembly No. 1.
- Elevation Error Channel – Three waveguide runs connecting LCP El Error feed port to the Switch Assembly No. 2.
- Azimuth Error Channel – Five waveguide runs connecting RCP Az Error and LCP Az Error feed ports to the Switch Assembly No. 3.
- Output Transmission Line – Two waveguide runs connecting to the Switch Assembly No. 1. The interface flange of the terminal waveguide run is located approximately 3.00 inches above the base flange of the Cassegrain Cone.

2.2.12 Each waveguide run is a brazed assembly made from 0.125-inch-thick wall, 6061-F aluminum alloy waveguide stock, and 0.470-inch-thick welded flanges.

2.2.13 Each waveguide run conforms to JPL Specification "DSIF-STD Procedure 1005, Waveguide Flange, WR-430. When finished all waveguide runs are in T-4 condition. Of the total of fourteen waveguide runs only two new assembly drawings were made. Two existing assembly drawings, D9335146 and D9335148, were redrawn on "J" size vellum to enable the expansion of the table for new sizes of the waveguide runs. Typical waveguide runs are shown in Figure 6.

2.2.14 Support Structure – The R. F. equipment support structure consists of:

1. Cassegrain Cone
2. Four sets of rigid rail-mounting feed supports
3. Switch assembly and waveguide run brackets

2.2.15 The Cassegrain Cone, J9431342, constitutes the primary support structure. It consists of three cone sections. The upper section, Figure 8, a non-structural cone member, is 26.00 inches long with 22 inches diameter at the upper end and 30.50 inches diameter at the lower end. It is mounted from without to the upper flange of the center cone section.

2.2.16 The two-section cone, Figure 9, is 57.00 inches long, with 31.00 inches diameter at the upper end and 50.00 inches diameter at the base. Each of the two sections is made up of eight stringers, two interface mounting flanges and eight panels.

2.2.17 The accessibility to R. F. equipment within the cone is provided through four removable bolted panels in the lower section of the cone, and through 40.00 inch diameter flange opening at the base. In addition, the upper section of the cone can be unbolted and removed from the cone, if the accessibility to the upper end of the feed is required. The temporary accessibility to the center section of the cone is provided through four openings corresponding to the panels Nos. 1, 4, 5, and 8, counting clockwise from "Az Ax Top" reference designation of the cone in the top view JPL drawing J9431342.

2.2.18 This accessibility facilitates the handling of the tools within the center cone section during the initial stages of the SCM-30 Cone Assembly installation. When this installation is completed these four panels are permanently riveted to the cone.

2.2.19 The cone is designed to meet all weather-tight requirements. The gaps between adjacent riveted panels are sealed with adhesive-sealant, silicone rubber compound. All bolted panels are backed-up with rubber gaskets. The interface base flange of the cone is sealed from the antenna hub with a rubber "O" ring gasket. It is placed within the appropriate "O" ring groove located on the outside of the interface base flange bolt circle. The cone is provided with four lifting lugs; two lugs are mounted at the upper end of the center cone section and two at the base of the lower cone section, all lying in the azimuth plane.

2.2.20 The support structure within the Cassegrain Cone consists of four rigid rail-mountings longitudinally fastened to the upper and lower flanges of the center cone section, Figure 9. Their function is:

1. To provide the support for the feed assembly, one switch assembly and several waveguide runs.
2. To provide the framework for the alignment of the feed assembly.

2.2.21 The rail-mountings are so oriented within the cone, that the reference planes passing through the inner faces of the adjacent rails are parallel or perpendicular, as the case might be, to the azimuth and elevation reference designation planes of the Cassegrain Cone.

2.2.22 Brackets constitute a secondary support structure. They are used to support switch assemblies and waveguide runs. Of the total eleven simple brackets, six are used directly or indirectly to support the three switch assemblies to cone structure; five are used to support waveguide runs, mostly for the purpose of shortening the unsupported lengths, thus increasing their natural frequencies and so improving their mechanical stability.

2.3 INSTALLATION AND ALIGNMENT PROCEDURE

2.3.1 The installation and alignment procedure for the SCM-30 Cone Assembly should proceed in the order described in the following sections with the aid of the following drawings:

- J9431329 Layout, SCM-30 Cone Assembly (Ref. 9 & 10)
- J9431331 SCM-30 Cone Assembly (Ref. 9 & 10)
- J9431332 Feed Assembly (Ref. 9 & 10)

2.3.2 Cassegrain Cone, J9431342 –

1. Establish flat horizontal mounting platform.
2. Assemble together the lower and the center sections of the cone. Apply waterproof non-hardening sealant "Permagam", Item 41,

JPL drawing J9431342, between the mating surfaces of the adjacent sections.

3. Place the two-section cone in the upright position on the horizontal mounting platform.

4. Establish vertical reference planes coinciding with azimuth and elevation axes of the cone. The intersection of these planes establishes the longitudinal centerline of the Cassegrain Cone.

2.3.3 Rail-Mounting, Feed, D9431359, D9431373, D9431375

1. Lower four rail-mountings into the center section of the Cassegrain Cone and locate them in the upright position at 45° with respect to cone axes in the following order:

   - D9431359, one each in the first and second quadrant (counting clockwise with respect to "Az **Ax Top**" reference designation section A-A, JPL drawing J9431331, Sheet 2 of 2)
   - D9431375 in the third quadrant.
   - D9431373 in the fourth quadrant.

2. Clamp each rail-mounting with appropriate plate-mounting and angle support (see sections C-C, D-D, and E-E, JPL drawing J9431331, sheet 2 of 2).

3. Align four rail-mountings, so that the inner faces of the adjacent rails are parallel and symmetrical to each other with respect to the Cassegrain Cone axes within ±.03 inch. The space between the inner faces of the adjacent rails is to be 19.00 inches. The dummy frame 19.00 by 19.00 inches can be used to facilitate the alignment of the rail-mountings.

4. Use existing holes in the clamped rail-mountings to locate and drill holes in the cone structure.

5. Permanently bolt rail-mountings with associated support components to the cone structure and then dowel pin all joints in place.

2.3.4 Feed Assembly, J9431332 –

1. Assemble the following components of the feed:

• Quadruple Orthomode Transducer	J9335036
• Phase Shifter	J9431335
• Side Wall Coupler	J9431334
• Folded H-Plane Magic Tee, L.H. and R.H.	J9335050-1 & -2
• Magic Tee, Large	J9335076-1
• Magic Tee, Small	J9335129

2. Install four mount adapters, C9335103, to the four elbow flanges of the quadruple orthomode transducer and then mount support adapter, D9431367.

3. Mount two bracket supports, C9431371, to the side wall coupler rear double flange, and then mount support adapter, D9431370.

4. To the partially assembled feed, add the following remaining feed components:

• Circular Polarizer	D9335068
• Multimode Matching Section	J9431336
• Horn	J9431337
• Radome	C9431338
• Adapter Feed	J9431333
• Loads	B9335879

5. Seal all interface flange openings, exposed threads, and dowel pin holes with Item 41, JPL drawing J9431332.

6. Loosely fasten shoe riders, C9431368 and C9431369, to two support adapters.

7. Install the feed assembly into the Cassegrain Cone and clamp in place. The front face of the horn is 84.83 ±0.12 inches from the lower section cone base. The feed assembly is so oriented within the cone that while the "LCP Sum" and LCP Az Error" ports of the feed lie in elevation axis, the "RCP Sum" port of the feed points towards "Az Ax Top",

reference designation of the cone, looking down, cone in the upright position.

8. Align the longitudinal centerline of the feed assembly to coincide with that of the cone within ±.015 T.I.R.

9. Use existing holes in the shoe riders to locate and drill holes in the rail-mountings, then bolt shoe riders and dowel pin all joints in place.

10. Install the radome cover.

11. Install the upper cone section.

2.3.5 Switch Assembly No. 1 –

1. Clamp bracket mounting SW. No. 1, D9432646, to the rail-mounting, D9431359.

2. Bolt bracket angle, C9432656, and plate support, C9432657, to the bracket-mounting SW. No. 1.

3. Mount Switch Assembly to the bracket mounting Switch No. 1. The switch connector is in the plane parallel to elevation plane pointing towards "Az Ax Top".

4. Install Load B9335879 to the switch assembly port No. 3.

5. Install two output waveguide runs from the switch assembly port No. 1 in the following order: J9335148-22, J9335146-20.

6. Install one Waveguide Run, J9335148-21 from the switch assembly port No. 2 to the "RCP-Sum" feed port.

7. Install a set of waveguide runs from the switch assembly port No. 4 to the "LCP-Sum" feed port in the following order: J9335148-20, D9431339, J9335148-19.

8. Align the switch assembly with bracket mounting as necessary, to provide proper interface flange matchings.

9. Locate and drill holes at assembly, bolt all brackets to the support structure and dowel pin joints in place.

2.3.6 Switch Assembly No. 2 –

1. Clamp bracket support, C9432658 and bracket mounting SW. No. 2, J9432640, to the cone structure on azimuth axis approximately as shown, section B-B, JPL drawing J9431331.

2. Mount switch assembly to the bracket mounting SW. No. 2. The switch connector is on azimuth axis pointing away from the center of the feed.

3. Bolt the flange of the "RCP El Error" feed port to the switch assembly flange, port No. 3. Align the switch assembly with supporting brackets as necessary, to provide proper interface flange matching.

4. Install 7/8 coax to waveguide transition, D9334996 and the load B9335879 to the switch assembly port Nos. 4 and 2 respectively.

5. Install a set of waveguide runs from the switch assembly port No. 1 to the "LCP El Error" feed port in the following order: D9335143-4, D9431355, J9335146-19.

6. Locate and drill holes at assembly, bolt the bracket support and bracket mounting to the cone structure, and dowel pin joints in place.

2.3.7 Switch Assembly, No. 3 –

1. Clamp bracket mounting SW. No. 3, J9432641, to the cone structure on the elevation axis, rotating 90° counter clockwise with respect to "Az Ax Top" approximately as shown.

2. Mount switch assembly to the bracket mounting SW. No. 3. The switch connector is pointing in the same direction as that of the Switch No. 1.

3. Install 7/8 coax to waveguide transition D9334996 and the load D9335879 to the switch assembly port Nos. 4 and 2 respectively.

4. Install a set of waveguide runs from the switch assembly port No. 1 to the "RCP **Az** Error" feed port in the following order: J9335146-17, J9335148-23, J9335146-18.

5. Install a set of waveguide runs from the switch assembly port No. 3 to the "LCP Az Error" feed port in the following order: D9431339-2, J9335148-1.

6. Align the switch assembly with bracket mounting as necessary, to provide proper interface flange matchings.

7. Locate and drill holes at assembly, bolt the bracket mounting to the cone structure and dowel pin joints in place.

2.3.8 Miscellaneous –

1. Seal all interface flange openings from without, exposed threads, and dowel pin holes with item 41, JPL drawing J9431332.

2. Rivet in place remaining panels in the center section of the cone.

3. Bolt in place four removable panels backed with rubber gaskets in the lower section of the cone.

4. Seal all gaps between all riveted panels and around the base of the lifting eye with polysulphite adhesive as per note 19, JPL drawing J9431331.

5. Cover the base of the SCM-30 cone assembly with protective aluminum cover.

6. Clean the outside surfaces of the cone and finish paint per JPL specification DSIF-STD Procedure 1006.

2.4 PRESSURIZATION

2.4.1 After the SCM-30 Cone Assembly is installed, the R. F. components are filled with dry nitrogen and held at a constant pressure of 0.3 psi. The purpose of the pressurizing is to keep moisture out of the system. This prevents high power breakdown, noise during diplexing, corrosion of the R. F. components, and in turn maintains a low insertion loss.

2.4.2 The dry nitrogen enters the system through the switch assembly No. 1 output port waveguide run, J9335146-20, and leaks out of the system through miniature gaps between the intermating flanges.

2.4.3 The system pressure leak check is the last operation before the SCM-30 Cone Assembly is made available for delivery. Its purpose is to assure that the leakage rate of the dry nitrogen of the system is within the requirements of the design specifications.

2.4.4 To facilitate this operation a preliminary leakage rate check is made on the Feed Assembly prior to its installation into the cone. The pressure leakage rates for the two Feed Assemblies and two SCM Cone Assemblies are shown in Table 4.

Table 4. Nitrogen Pressure Leakage Rates

Name	Serial No.	Leakage Rate in cm^3/min.
Feed Assembly	1	50.0
Feed Assembly	2	140.0
SCM-30 Cone Assembly	1	280.0
SCM-30 Cone Assembly	2	320.0

The pressure leak test procedure and the original data are in the Appendix.

2.5 STRESS AND DYNAMIC ANALYSIS

2.5.1 Cassegrain Cone – The Cassegrain Cone is a cantilever supporting framework for the feed system. It is designed for maximum stiffness and minimum deflections to meet electrical boresight requirements. Since the weight of the SCM-30 cone assembly is not critical, the cone was designed with sufficient stiffness to have a fundamental frequency of over 50 cps. The dynamic analysis of the cone was carried out utilizing the Rayleigh method. This technique consists of assuming the anticipated deflection curve for the structure, calculating the maximum potential and kinetic energies of the structure, and equating these maximums to find the fundamental frequency.

2.5.2 Hughes Aircraft Company in the past has analyzed similar feed cones and has prepared a digital computer program for performing the analysis on the IBM 7094. This existing program was used in determining the fundamental frequency of the cone. The analysis indicates that the fundamental frequency of the cone is 72.78 cps.

2.5.3 In addition to the dynamic analysis of the cone, the mounting bolts of the cone and the lifting eyes were stressed for dynamic loads up to 5 G's and 10 cps. Calculations indicate that the stress levels are well within the yield point of the material.

2.5.4 Feed Assembly – The feed assembly is identical in structure and construction to the one used in the 85-foot SCM Cone Assembly, with the exception that it is lighter and shorter. Since the electrical components have the same wall thickness and are supported in the same manner as in the 85-ft-diameter reflector, it has been assumed that the feed assembly possesses the required stiffness for proper electrical performance.

2.5.5 Waveguide Runs – A vibration analysis of the waveguide runs was conducted by assuming the waveguide to be a simply supported beam. At first a natural frequency of 10 cps was found for a simply supported length of about 3.30 feet. On this basis, it was recommended that the waveguide run be rigidly supported at lengths of no more than 3 feet. This will raise the minimum natural frequency to a range where the input is low and will not cause severe dynamic stressing of the waveguide walls.

2.5.6 Brackets – Of the eleven brackets used on the SCM-30 Cone Assembly, only three switch brackets are used to support the significant concentrated load. The remaining eight brackets are used to support the waveguide runs of insignificant concentrated loads. By inspection, the analysis was limited to the weakest of the three switch brackets and mounting hardware. The calculated stresses are 1020 psi.

2.5.7 Conclusion – The SCM-30 Cone Assembly components are structurally sound, and can withstand the handling vibration requirements of 5 G's with frequency components up to 10 cps.

2.6 NEW TECHNOLOGY

Data for this section in this report is not applicable.

2.7 RELIABILITY

2.7.1 No specific reliability contract requirements were applicable on this program due to the passive nature of the basic feed components. No special evaluation programs were applied at the part level since the waveguide switch assemblies were the only parts having recognizable failure mode, and these switch assemblies were furnished by JPL.

2.7.2 All applicable inspections have been accomplished during the manufacturing cycle to assure sound mechanical integrity of the end product.

2.8 MATERIALS

2.8.1 The primary material used to fabricate SCM-30 Cone Assembly is aluminum alloy 6061 in -T4 or -T6 condition. All waveguide runs and feed components are in -T4 condition, while all support structure components are in -T6 condition. All waveguide runs and some feed components are made from WR-430 waveguide with wall thickness of 0.125 inch.

2.8.2 Hardware used on the SCM-30 Cone Assembly consists of bolts, screws, nuts, splitring, lockwashers, flat washers, quick disconnect camlocks, nut plates, thread inserts, and rivets. Except for aluminum rivets, only stainless steel hardware is used; whenever 300-series hardware was not available, 400-series hardware was purchased and cadmium-plated for maximum protection against corrosion.

2.9 FINISHING PROCESS

2.9.1 Finishing processes are used to provide suitable anti-corrosion protection to all components. Five processes are used: chemical finish per MIL-C-5541, cadmium plate per QQ-P-416, passivate per MIL-STD-171, paint per JPL specification DSIF-STD procedure 1006, and white epoxy paint per JPL specification DOM-1115-DSN.

2.9.2 Chemical finish is applied to all aluminum components. The treatment of R. F. components requires time control (approximately 25 sec duration) to reduce the thickness of deposited film (very light orange coloration), thereby reducing the insertion losses of the R. F. components. All non-R. F. components are given full treatment as required per MIL-C-5541.

2.9.3 For maximum protection against corrosion the 300-series stainless steel hardware is passivated and 400-series stainless steel hardware is cadmium plated, Class 2, Type 2.

2.9.4 Exterior surfaces of all R. F. components are painted with white epoxy paint as required per JPL specification DOM-1115-DSN, and exterior surface of the Cassegrain Cone are painted per JPL specification DSIF-STD Procedure 1006.

2.10 SPECIFICATIONS

2.10.1 In the fabrication of the SCM-30 Cone Assembly operations were performed in conformity to applicable MIL specifications or JPL specifications. If no applicable MIL or JPL specifications existed, Hughes Specifications were used. All specifications used are listed in Appendix II.

3. DOCUMENTATION

3.1 The documentation of the SCM-30 Cone Assembly conforms to JPL specification No. DOO-1022 GEN, entitled "General Specification for Contractor Furnished Documentation". The drawings were prepared on JPL vellum, using JPL DDM and DSIF Drafting Practice Memoranda. MIL-D-70327 were applied whenever the DDM did not delineate a specific requirement. The parts list of the SCM-30 Cone Assembly is in the Appendix I.

4. PACKAGING

4.1 Packaging was not a part of the requirement in this program. However to facilitate the handling of the equipment the base of the cone was rigidly mounted to the wooden frame.

5. DELIVERIES

5.1 Two SCM-30 Cone Assemblies were built and made available for JPL pick-up. The serial numbers of the systems along with JPL buy-off and shipping dates and Hughes shipping numbers are shown in Table 5.

Table 5. SCM-30 Cone Assembly, Schedule of Delivery

Serial No.	Dates		Hughes Shipping No.
	Buy-off	Shipping	
1	14 July 1965	15 July 1965	155-102223
2	21 September 1965	23 September 1965	155-103966

5.2 In addition, one set of autopositives and two sets of blueprint copies of Class I drawings were delivered to JPL. The number of drawings and shipping dates along with Hughes letter number are shown in Table 6.

Table 6. Documentation Schedule of Deliveries

No. of Drawings	Sets of Blueprints	Date of Shipment	Hughes Letter No.
55	2	30 July 1965	65R-3481/A6583
8	2	15 September 1965	64R-4041/A6583

6. REFERENCES

1. Statement of Work, DSIF, S-Band Cassegrain Monopulse Cone Assembly, 30-Foot Antenna, No. 332-SW-314, dated 10 December 1964.

2. Design Specification, DSIF S-Band Cassegrain Monopulse Feed, 30-Foot Antenna, JPL Specification DOM-1112-DSN, dated 9 December 1964.

3. Design Specification, DSIF S-Band Cassegrain Monopulse Cone Assembly, 30-Foot Antenna, JPL Specification DOM-1115-DSN, dated 10 December 1964.

4. JPL letter (Peter S. Ryken), dated 2 March 1965.

5. Meeting at Hughes premises between JPL (R. Hartop) and HAC (P. A. Jensen and W. Michalski) 10 March 1965.

6. P. A. Jensen, "A Low Noise Multimode Cassegrain Monopulse Feed With Polarization Diversity," NEREM Record, November 1963.

7. "S-Band Acquisition Antenna System Final Report," Hughes Aircraft Company, Fullerton, California, Document No. RF 64-14-109, 12 June 1964, pp. 1-3 to 1-19, JPL Contract No. 950704.

8. "S-Band Cassegrain Monopulse (SCM) Cone Assembly Final Report," Hughes Aircraft Company, Fullerton, California, Document No. FR 64-14-134, Contract No. 950678, additional two SCM cone assemblies for DSIF 85-ft-diameter antennas were made under Contract No. 950981. The second in this contract or seventh of the total was delivered on 27 January 1965.

9. HAC Letter No. 65R-3481/46583 (R. E. Wheeler) to JPL (P. S. Ryken), dated 30 July 1965. Partial Documentation Submittal.

10. JPL Letter (P. S. Ryken) to HAC (R. Wheeler) dated 25 October 1965. Final Documentation Submittal.

Appendix I

PARTS LIST FOR SCM-30 CONE ASSEMBLY, J9431331

Appendix I

1. PARTS LIST FOR SCM-30 CONE ASSEMBLY, J9431331

Part/Drawing No.	Title
D9334996	7/8 Coax-to-W/G Transition (JPL Supplied)
D9335019	Flange
J9335036	Transducer, Quadruple Orthomode
D9335037 (Obsolete)	Flange
D9335038	Flange
D9335040	Side
D9335041	Side
D9335042	Divider
D9335043	Divider
C9335044	Divider
C9335047	Waveguide
C9335048	Waveguide
B9335049	Miter, Cover
J9335050	Folded H-Plane Magic Tee
C9335051	Waveguide
J9335052	Waveguide
B9335053	End Plate
B9335054	Post
B9335055	Tuning Bar
B9335056	Button
B9335057	Post
D9335059	Cover Plate
B9335060	Side Plate
C9335061	Corner Block
B9335062	Baffle
C9335063	Miter Side
B9335064	Miter Cover

PARTS LIST (Continued)

Part/Drawing No.	Title
D9335065	Waveguide
C9335066	Waveguide
C9335067	Support
D9335068	Circular Polarizer
D9335069	Side
D9335070	Side
D9335071	Divider
D9335072	Divider
C9335073	Wedge
C9335074	Wedge
C9335075	Post
D9335076	Magic Tee
B9335077	Post
D9335080	Waveguide
C9335081	Waveguide
C9335082	Waveguide
D9335083	Plate, Matching Device
B9335084	Post
C9335086	Baffle
B9335087	Post
D9335088	Flange
D9335089	Hybrid
C9335090	Button
D9335091	Hybrid Cover
C9335093	Post
D9335094	Waveguide
C9335095	Button
D9335096	Flange-Waveguide WR-430
C9335097	Button

PARTS LIST (Continued)

Part/Drawing No.	Title
C9335103	Mount-Intermediate Adapter
B9335114	Modified WR-430 Waveguide
J9335115	Double E-Plane Tee
D9335116	Flange
D9335117	Flange
C9335118	Block
C9335119	Waveguide
D9335120	Waveguide
B9335121	Button
B9335125	Divider
C9335128	Waveguide
J9335129	Magic Tee
C9335131	Waveguide
C9335132	Waveguide
D9335133	Waveguide
C9335137	Waveguide
D9335143	Waveguide Run, Double Elbow
J9335146	Waveguide Run, 90° Elbow
J9335148	Waveguide Run, 90° Elbow
C9335159	Cover, Miter
D9335163	Waveguide
D9335164	Waveguide
D9335166	Waveguide
D9335177	Post
D9335198	Clamp-Waveguide
B9335223	Stud
D9335224	Waveguide
C9335234	Rod
D9335243	Post

PARTS LIST (Continued)

Part/Drawing No.	Title
D9335264 (Obsolete)	Blank Flange (See 9335156)
B9335863	Pin, Locating
B9335879	Load (JPL supplied)
D9335900	Switch Assembly (JPL supplied)
J9431329	Layout, SCM-30 Cone Assembly
J9431330	Outline, SCM-30 Cone Assembly
J9431331	SCM-30 Cone Assembly
J9431332	Feed Assembly
J9431333	Adapter, Feed
J9431334	Side Wall Coupler
J9431335	Phase Shifter
J9431336	Multimode Matching Section
J9431337	Horn
D9431338	Radome
D9431339	Waveguide Run, Double Elbow
C9431340	Waveguide
J9431342	Cone, Cassegrain
B9431343	Button
C9431344	Waveguide, Adapter Feed
B9431345	Post, Adapter
D9431346	Side, Multimode M. Sect.
D9431347	Side, Multimode M. Sect.
D8431348	Side, Multimode M. Sect.
D9431349	Side, Multimode M. Sect.
C9431350	Divider, Multimode M. Sect.
C9431351	Divider, Multimode M. Sect.
C9431352	Iris, Multimode M. Sect.
B9431353	Pin, Multimode M. Sect.
D9431355	Waveguide Run, Toggle Sect.

PARTS LIST (Continued)

Part/Drawing No.	Title
C0431356	Waveguide
D9431359	Rail-Mounting, Feed
D9431360	Flange, Horn
C9431361	Side, Horn
D9431362	Flange, Horn
D9431363	Flange, Horn
B9431364	Gusset, Horn
D9431365	Gasket, Horn
D9431367	Support Adapter, Feed
C9431368	Shoe-Adapter, Feed
C9431369	Shoe-Adapter, Feed
D9431370	Support Adapter, Feed
C9431371	Bracket Support, Feed
D9431372	Cover, Radome
D9431373	Rail-Mounting, Feed
D9431374	Ring, Radome
D9431375	Rail-Mounting, Feed
C9431376	Angle, Support Feed
C9431377	Plate, Mounting Feed
C9431378	Plate, Mounting Feed
J9432640	Mounting Bracket, SW. No. 2
J9432641	Mounting Bracket, SW. No. 3
B9432642	Plate, Iris
C9432643	Plate, Iris
C9432644	Iris
C9432645	Iris

PARTS LIST (Continued)

Part/Drawing No.	Title
D9432646	Mounting Bracket, SW. No. 1
C9432649	Bracket Support, Waveguide
C9432650	Bracket Support, Waveguide
C9432651	Bracket Support, Waveguide
C9432653	Bracket Support, Waveguide
B9432654	Post, Waveguide Run
C9432656	Bracket, Angle
C9432657	Plate Support
C9432658	Bracket Support
D9432659	Bracket Support, Waveguide
C9432660	"O" Ring, Cone

Appendix II

SPECIFICATIONS USED IN FABRICATION OF SCM-30 CONE ASSEMBLY

Appendix II

1. SPECIFICATIONS USED IN FABRICATION OF SCM-30 CONE ASSEMBLY

ITEM	MIL SPEC	JPL SPEC	HAC SPEC	PROCESS
1	MIL-C-5541			Chemical Film, Aluminum and Aluminum Alloys
2	MIL-F-14072			Finishes for Ground Signal Equipment
3	MIL-H-6088			Heat Treatment of Aluminum
4	MIL-I-6866			Penetrant Inspection, Welds
5	MIL-S-5002			Passivate Stainless Steel
6	MIL-S-7742			Screw Thread, Standards
7	MIL-STD-10			Surface Roughness
8	MIL-W-8604			Fusion Welding of Aluminum
9	MIL-W-6860			Spot & Seam Welding of Aluminum
10	QQ-P-416			Cadmium Plating
11		ZPO-2002-PRS-C		Process Specs, Identification Requirements, Parts and Assemblies
12		DOM-1112-DSN		Design Specs, DSIF S-Band Cassegrain Monopulse Feed, 30-Foot Antenna
13		DOM-1115-DSN		Design Specs, DSIF S-Band Cassegrain Monopulse Cone Assy, 30-Foot Antenna
14		GMO-50139-GEN-A		General Specs, Quality Control Requirements for Ground Support Equipment
15		1005		Waveguide Flange, WR-430 Fabrication and Assembly
16		1006		Painting or Thermal Coating DSIF Antennas and Supporting Structures
17			780022	Adhesive, Epoxy-type, Electrically Conductive Application of
18			780047-1	Application of General Purpose Contact-Bond Type, Adhesive

SPECIFICATIONS USED IN FABRICATION OF SCM-30 CONE ASSEMBLY
(Continued)

ITEM	MIL SPEC	JPL SPEC	HAC SPEC	PROCESS
19			780065	Application of Transparent Epoxy Poly-Sulphide Rubber Type, Adhesive
20			780104	Application of Flexible Adhesive
21			780399-2	Installation of Protruding Head Rivets
22			780399-5	Installation of Blind Rivets
23			780399-11	Installation of Nut Plates
24			780399-16	Screw Torque Requirement 10-32 to 1 1/4 - 1/2 range.
25			780399-17	Installation and Inspection of Rosan Inserts
26			783499-3	Aluminum Dip Brazing

Appendix III

TEST DATA

Appendix III

TEST DATA

ELECTRICAL PROCEDURES AND TEST DATA

III - A. ACCEPTANCE TEST PROCEDURE
DSIF S-BAND CASSEGRAIN
MONOPULSE FEED
(30 - FOOT ANTENNA)

Appendix 3

TEST DATA

1. SCOPE

This acceptance test document covers the test required to verify the electrical performance of the S-Band Cassegrain Monopulse Feed.

2. APPLICABLE DOCUMENTS

Drawings

Jet Propulsion Laboratory

9431332	Feed Assembly

Specifications

Jet Propulsion Laboratory

DOM-1112-DSN	Design Specification DSIF S-Band Cassegrain Monopulse Feed

Other Publications

Microwave Measurements, Edward L. Ginztion, McGraw-Hill Book Company, Inc., New York, 1957

Techniques of Microwave Measurements, Carol G. Montgomery, McGraw-Hill Book Company, Inc., New York, 1947.

Making Microwave Measurements, Pat Taciarone, Electronic Industries, June, 1962.

3. TEST PREPARATIONS

3.1 Test Equipment — The following test equipment, or equivalent, shall be provided:

			Quantity
(a)	R F Generator	HP 616 B	1
(b)	Square Wave Generator	HP 211 A	1
(c)	Low Pass Filter	μLab LA 30 N	1
(d)	Frequency Meter	FXR N 410 A	1
(e)	Isolator	Sperry D44L 43-25	1
(f)	Slotted Line	Narda 225 B	1
(g)	Tunable Probe	Sperry 28B1	1
(h)	Standing Wave Indicator	HP 415 B	2
(i)	Waveguide Detector Mount	Narda 535	2
(j)	Bolometer	Narda N 610 B	2
(k)	Waveguide Load	Narda 305	7
(l)	Coax Detector Mount	PRD 613	2
(m)	Coax-WG Adapter	Narda 615	1
(n)	TWT	Alfred 5-6868	1
(o)	Pattern Recorder	Antlab 1845	1
(p)	Serrodyne Phase Bridge		1
(q)	Directional Couplers	10 and 20 db	2

3.2 Test Conditions

3.2.1 Environment – The tests shall be performed at prevailing laboratory or test site atmospheric conditions.

3.2.2 Equipment Warmup – Equipment shall be permitted a warmup period of 15 minutes before any of the acceptance tests are performed.

3.2.3 Calibration – Test equipment used to conduct tests shall be calibrated at such intervals as are necessary to insure maintenance of the accuracies required. Evidence of calibration shall be attached to each instrument together with the next calibrated due date.

3.2.4 Equipment Setup — Test shall be performed using the setups shown in section 4.0 or equivalent.

3.2.5 Test Measurements — Tests shall be performed using standard measurement techniques or equivalent and shall be conducted in the manner described in section 4.0.

3.2.6 Test Data — Test data shall be recorded in accordance with the DATA SHEET of section 4.0. Copies of the test data shall be provided to the customer.

4. TEST PROCEDURE

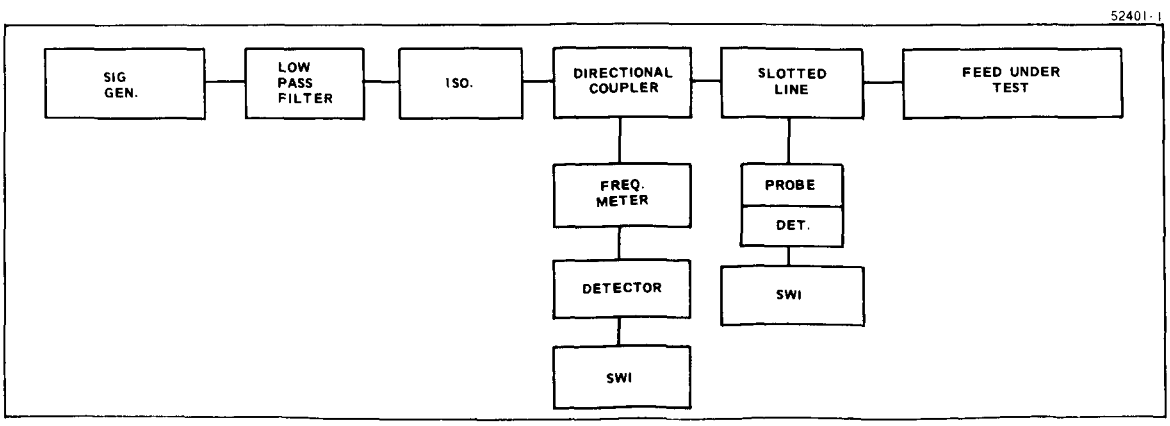
4.1 VSWR

4.1.1 Requirements

(1) The VSWR of each sum channel shall not exceed 1.10 at 2110 ± 10 Mc and 2285 ±15 Mc.

(2) The VSWR of each error channel shall not exceed 1.20 at 2290 ± 10 Mc.

4.1.2 Test Setup



4.1.3 Measurements

(1) Connect the RCP Σ port of the feed under test into the setup as shown.

(2) Measure the VSWR.

(3) Repeat steps (1) and (2) for the remaining five ports.

4.1.4 Data Sheet

Unit: ______________

Serial No.: ______________

Date: ______________

Test Personnel: ______________

Freq. (Mc)	VSWR						Limit
	RCPΣ	RCP AZ	RCP EL	LCPΣ	LCP AZ	LCP EL	
2100		--	--		--	--	1.10
2110		--	--		--	--	1.10
2120		--	--		--	--	1.10
2270		--	--		--	--	1.10
2280	--			--			1.20
2285		--	--		--	--	1.10
2290	--			--			1.20
2300		--	--		--	--	1.10
2300	--			--			1.20

4.2 Isolation

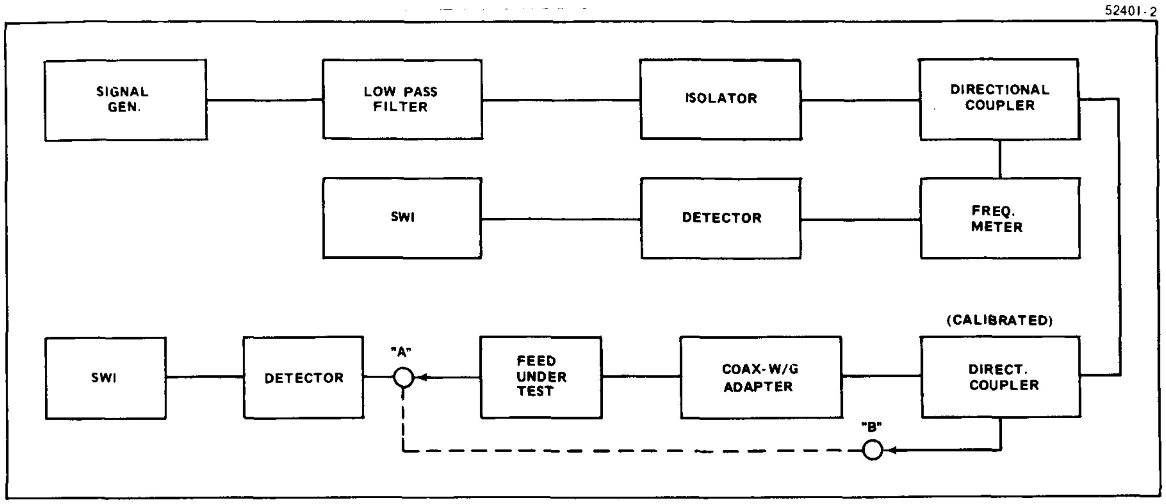
4.2.1 Requirements

(1) The isolation from each sum channel to the remaining seven channels shall be at least 30 db at 2110 ± 10 Mc and 2285 ± 15 Mc.

(2) Isolation from RCP to LCP error channels of the same plane shall exceed 15 db at 2285 ± 15 Mc.

(3) All other isolations at 2285 ± 15 Mc shall exceed 20 db.

4.2.2 Test Setup



4.2.3 Measurements

(1) With the detector connected to test point B, set a reference level on the SWI.

(2) Connect the detector to test point A and note the signal level on the SWI.

(3) The isolation is equal to the difference between the reference level in in Step (1) and the signal level in Step (2), plus calibrated coupling value (~20 db)

(4) Change test point A to each of the remaining ports, and repeat steps 2 and 3.

4.2.4 Data Sheet

Unit: ______________

Serial No.: ______________

Date: ______________

Test Personnel: ______________

	RCP Σ	RCP AZ	RCP EL	RCP X	LCP Σ	LCP AZ	LCP EL	LCP X	FREQ Mc
RCP Σ	O								2270
									2285
									2300
RCP AZ	R	O							2270
									2285
									2300
RCP EL	R	R	O						2270
									2285
									2300
RCP X	R	R	R	O					2270
									2285
									2300
LCP Σ	R	R	R	R	O				2270
									2285
									2300
LCP AZ	R	R	R	R	R	O			2270
									2285
									2300
LCP EL	R	R	R	R	R	R	O		2270
									2285
									2300
RCP Σ	O								2100
									2110
									2120
LCP Σ	R				O				2100
									2110
									2120

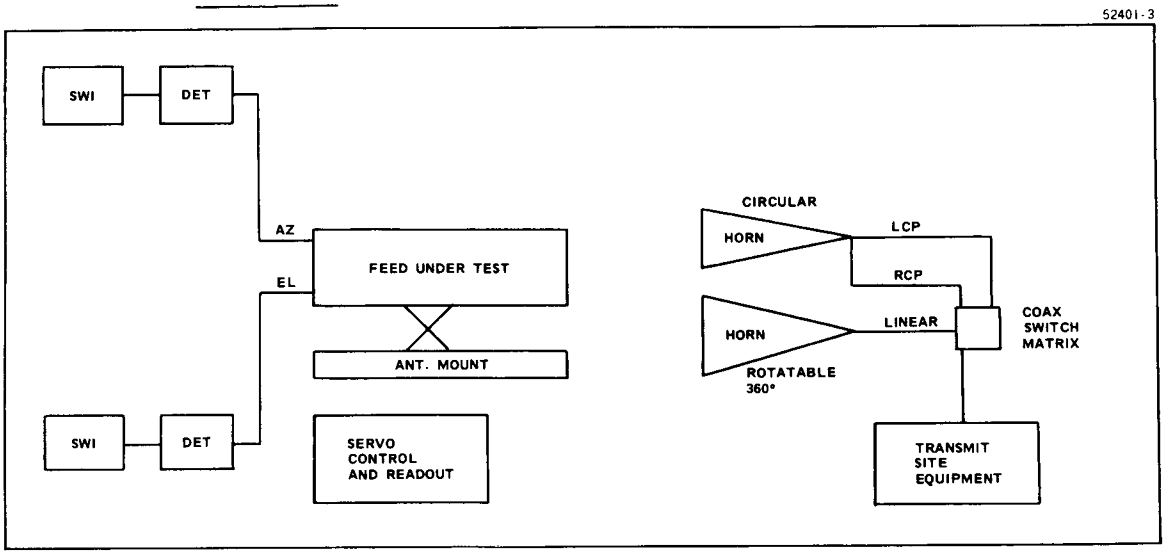
R = reciprocal reading

4.3 Boresight Vs. Polarization/Roll Error

4.3.1 Requirements*

(1) The position of the boresight for each sense of polarization shall not shift more than .02 degrees when the feed is installed in the cassegrain antenna.

4.3.2 Test Setup



4.3.3 Measurements

(1) Locate the boresight for the incoming linear signal and record the angular position of the feed (AZ and EL).

(2) Change polarization and relocate the boresight. Record the angular position of the feed.

(3) The boresight shift is the total variation of the angular position of the feed as the polarization is changed.

*Note: This measurement of primary boresight roll is for reference only. No limit is specified.

4.3.4 Data Sheet

Unit: ____________

Serial No.: ____________

Date: ____________

Test Personnel: ____________

Frequency - 2285

Polarization	RCP AZ	RCP EL	LCP AZ	LCP EL
H ↑				
45° ↗				
E →				
-45° ↖				

	Roll Error
RCP AZ	
RCP EL	
LCP AZ	
LCP EL	

4.4 Null Plane Orthogonality, RCP to LCP Null Plane Comparison and RCP to LCP Boresight Agreement

4.4.1 Requirements – When installed in the Cassegrain Antenna:

(1) Error channel null planes shall be orthogonal to within 2 degrees for each sense of circular polarization.

(2) Null plane pairs for LCP and RCP shall agree to within 10 degrees.

(3) Indicated boresight for LCP and RCP shall agree within .01 degree. *

4.4.2 Test Setup – Same as in paragraph 4.3.2, use circular polarization.

4.4.3 Measurements

(1) Position the feed on the mount such that the azimuth rotation is orthogonal to the azimuth null plane.

(2) Tilt the feed in incremental ** elevation steps either side of boresight and locate and record the angular position of the maximum null depths of the RCP AZ and LCP AZ error channels.

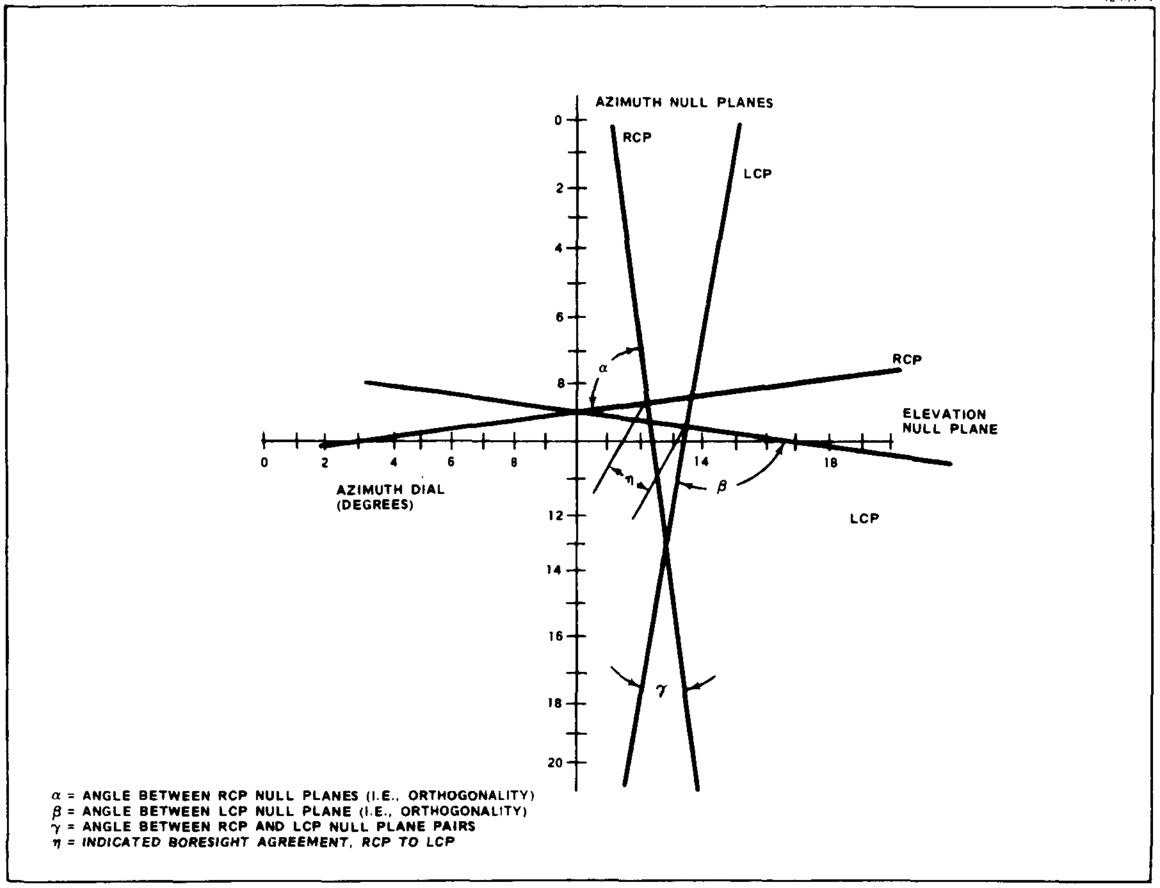
(3) Rotate the feed in incremental** azimuth steps either side of boresight and locate and record the angular position of the maximum null depths of the RCP EL and LCP EL error channels.

(4) Plot the data on rectangular graph paper and from this the null plane orthogonality, RCP to LCP null plane comparison and RCP to LCP boresight agreement is established. See Example, page III-11.

* Note: The measurement of indicated boresight of the primary feed is for reference only. No limit is set.

** Data should be taken in 1.0 degree increments, approximately 7 to 10 degrees each side of boresight (i.e., 15 to 20 data points).

Example: Null Plane Data Plots



α = angle between RCP null planes (i. e., orthogonality)

β = angle between LCP null plane (i. e., orthogonality)

γ = angle between RCP and LCP null plane pairs

η = indicated boresight agreement, RCP to LCP

4.4.4 Data Sheet

Unit: ______________

Serial No.: ______________

Date: ______________

Test Personnel: ______________

Null Plane Data*

RCP				LCP			
AZ Channel		EL Channel		AZ Channel		EL Channel	
AZ	EL	AZ	EL	AZ	EL	AZ	EL

* This data is plotted on rectangular graph paper.

4.4.4 Data Sheet (Continued)

Unit: ______________

Serial No.: ______________

Date: ______________

Test Personnel ______________

Null Plane Orthogonality

	Angle Between Null Planes	Limit
RCP Error Channels		$90 \pm 2^{\circ}$
LCP Error Channels		

RCP to LCP Null Plane Comparison

	Angle Between Null Planes	Limit
RCP to LCP		$\leq 10^{\circ}$

Boresight Agreement of RCP to LCP

RCP to LCP Indicated Boresight Agreement	

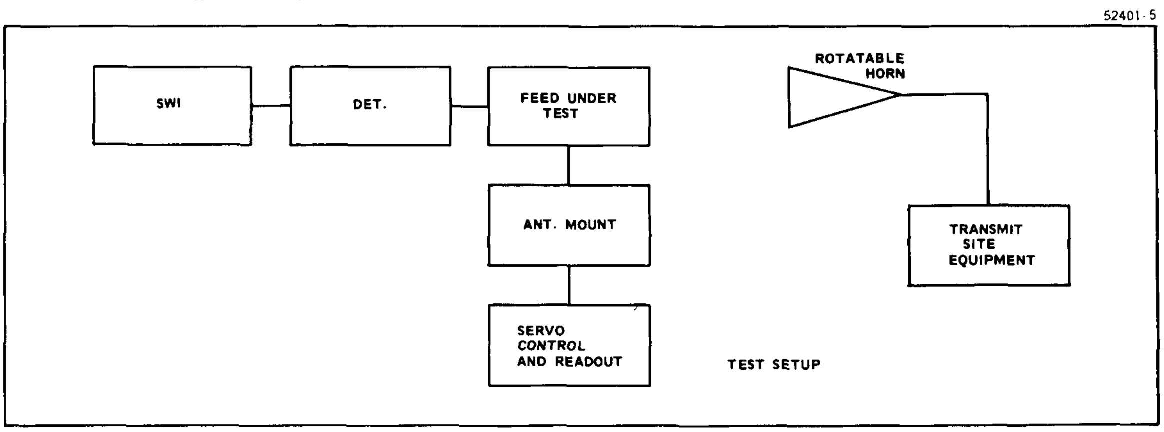
4.5 Ellipticity

4.5.1 Requirements

(1) The ellipticity of each sum channel shall not exceed 1.0 db at 2110 ± 10 Mc and 2285 ± 15 Mc.

(2) The ellipticity of each error channel main lobe shall not exceed 2.0 db at 2290 Mc.

4.5.2 Test Setup



4.5.3 Measurements

(1) Boresight the RCP Σ channel main beam on the transmitter.

(2) Rotate the linear polarized horn and record the signal variation (ellipticity) in decibels.

(3) Repeat Steps (1) and (2) for LCP Σ

(4) Boresight one of the main lobes of the RCP AZ channel on the transmitter.

(5) Repeat Step (2).

(6) Repeat Steps (4) and (2) for the remaining error channels.

4.5.4 Data Sheet

Unit: ______________

Serial No.: ______________

Date: ______________

Test Personnel: ______________

Freq.	Ellipticity RCP Σ	RCP AZ	RCP EL	LCP Σ	LCP AZ	LCP EL	Limit (db)
2100		--	--		--	--	1.0
2110		--	--		--	--	1.0
2120		--	--		--	--	1.0
2270		--	--		--	--	1.0
2285		--	--		--	--	1.0
2290	--			--			2.0
2300		--	--		--	--	1.0

4.6 Null Depth

4.6.1 Requirements

(1) The central null for each error channel shall be at least 30 db below the peaks of the error channel main lobes.

4.6.2 Test Setup — Same as in paragraph 4.5.2.

4.6.3 Measurements

(1) Boresight one of the main lobes of the RCP AZ error channel on the transmitter and note the signal level on the SWI.

(2) Rotate the antenna mount to the position of maximum null depth and note the signal level on the SWI.

(3) Null depth is the difference between the signal levels in Steps (1) and (2).

(4) Repeat Steps (1), (2), and (3) for the remaining error channels.

4.6.4 Data Sheet

Unit: ____________

Serial No.: ____________

Date: ____________

Test Personnel: ____________

Freq. (Mc)	Null Depth				Limit (db)
	RCP AZ	RCP EL	LCP AZ	LCP EL	
2280					$\geq$ 30
2290					$\geq$ 30
2300					$\geq$ 30

4.7 Pattern Characteristics

4.7.1 Requirements

(1) Hyperboloid shall be illuminated with an edge taper of 10.5 ± 1 db at 2285 ± 15 Mc.

(2) No shoulders shall be above 13 db.

(3) All sidelobes shall be below 20 db.

(4) The fraction of input power appearing within the 10.5 db beamwidth shall not be less than 85% as determined by pattern integration of four different planes (AZ, EL, and two diagonal planes) at 2295 Mc.

(5) The peak-to-peak separation of the error channel main lobes shall be less than 80% of the subtended angle of the hyperboloid.

(6) The error channel main lobes shall not be lower than 4 db below the appropriate sum channel peak at 2295 Mc.

4.7.2 Test Setup – Same as in paragraph 4.5.2 except the SWI is replaced by a pattern recorder.

4.7.3 Measurements

(1) Rotate the feed with the antenna mount and record the antenna pattern on the pattern recorder.

4.7.4 Data Sheet

Unit: ____________

Serial No.: ____________

Date: ____________

Test Personnel: ____________

4.7.4 Data Sheet (Continued)

Hyperboloid Edge Taper

Freq.	Taper RCPΣ	Taper LCPΣ	Limit (db)
2270			11 ±1
2285			
2300			

Sidelobe Level

Freq.	RCPΣ	LCPΣ	Limit (db)
2270			≥ 20
2285			
2300			

Efficiency

Plane	Integrated Efficiency (%)
Azimuth	
Elevation	
+ 45	
- 45	
Average	

The fraction of input power contained within the 11.0 db beamwidth is _____ at 2295.

Peak-to-peak Separation

Freq.	Peak-to-peak Separations RCP AZ	RCP EL	LCP AZ	LCP EL	Limit (deg)
2280					38
2290					
2300					

4.7.4 Data Sheet (Continued)

Sum-to-Error Channel Peak

Freq. (Mc)	RCP Channels		LCP Channels		Limit (db)
	Σ - AZ	Σ - EL	Σ - AZ	Σ - EL	
2290					0-4

4.8 Phase Patterns

4.8.1 Requirements

(1) Phase patterns shall be taken about the best 2295 Mc phase center of the feed in the azimuth and elevation planes for each sum channel at 2110 Mc and 2295 Mc and orthogonal to the null planes for each error channel at 2295 Mc.

4.8.2 Test Setup – See page III-20.

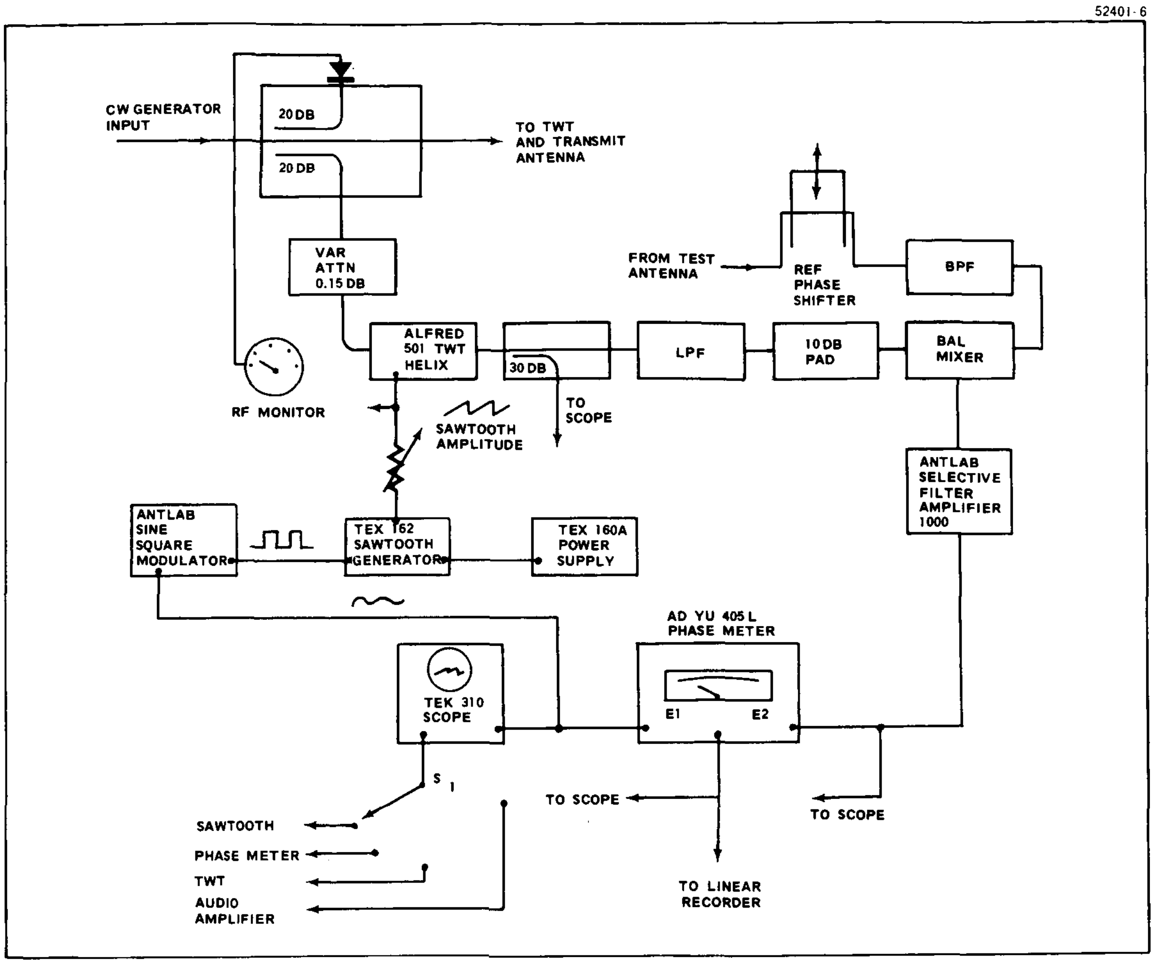
4.8.3 Measurements

(1) Rotate the feed with the antenna mount and record the phase pattern on the pattern recorder.

4.9 Insertion Loss

4.9.1 Requirements

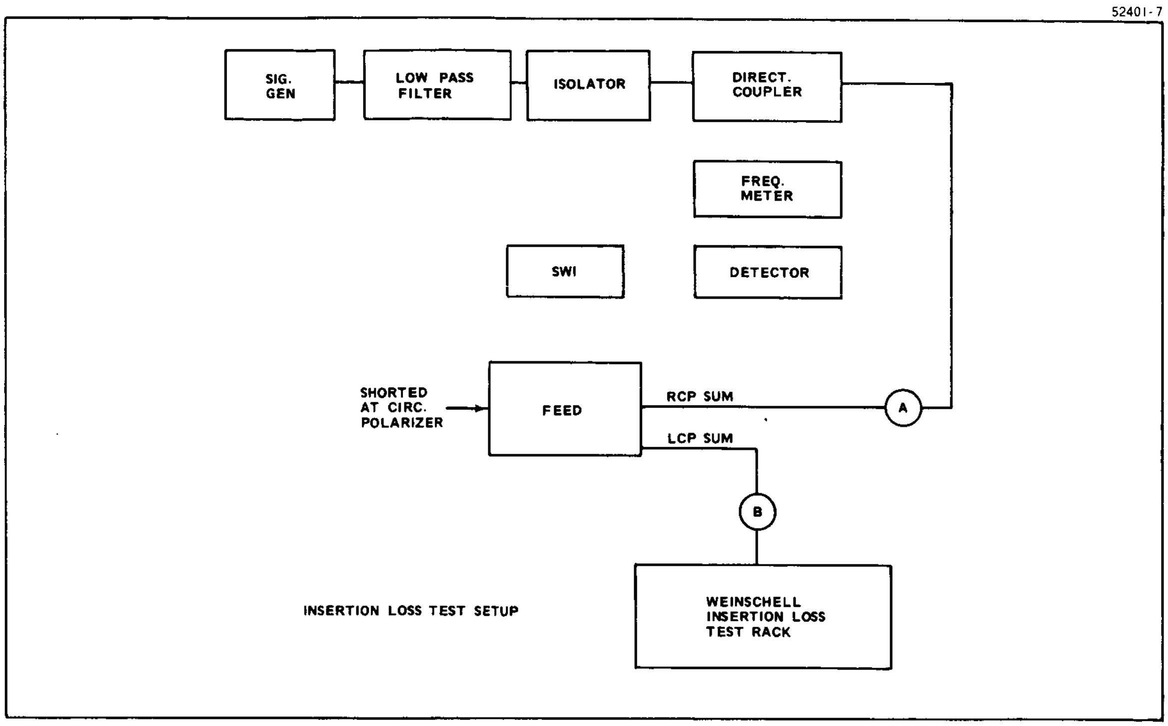
(1) The insertion loss of the feed shall be less than 0.06 db.



Test equipment used in the tests is listed below.

- Hewlett Packard 616A RF Signal Generator
- Hewlett Packard 491A Traveling-Wave-Tube Amplifier (TWT)
- Hewlett Packard 415B Standing-Wave Indicator
- Alfred 5-6868 TWT
- Tektronix 105 Square Wave Generator
- Narda 225B Impedance Meter (slotted line)
- Narda 535 Detector Mount (waveguide)
- Beckman 7580 Transfer Oscillator
- Beckman 7370 Frequency Counter
- Weinschel BA-1B Bolometer Preamplifier
- Weinschel CF-1 AF Substitution Attenuator
- Weinschel IN-1 Audio-Level Indicator
- Antlab Lin-Log Pattern Recorder
- Miscellaneous Low-Pass Filters
  Pads, Coax Detector Mount, Directional Couplers,
  Load Isolators

4.9.2 Test Setup



4.9.3 Measurements

(1) Take a reference reading with the Weinschell* rack connected to test point A.

(2) Connect the shorted feed between the test points A and B. Remove attenuation from the audio substitution attenuator in the Weinschell rack until the same reference reading is obtained. The attenuation removed is approximately** equal to twice the attenuation of the feed.

---

* Either single or dual channel insertion loss equipment may be used for this measurement.

** This measurement is to determine only relative insertion loss levels and is not considered precise enough to verify the actual feed loss. A measured loss of greater than twice the required feed insertion loss (i.e., 0.12 db) shall not necessarily be considered to indicate the feed does not meet specifications.

4.9.4 Data Sheet

Unit: ______________

Serial No.: ______________

Date: ______________

Test Personnel: ______________

Freq.	Two Way Loss	One Way Loss
2105		
2285		

III – B DSIF S-BAND CASSEGRAIN
MONOPULSE FEED
DATA SHEETS
SERIAL NO. 1

4.1.4 Data Sheet

Unit: SCM-30 Feed Assy

Serial No.: 1

Date: 6/3/65

Test Personnel: W. A. Leeper

Freq.	VSWR						
(Mc)	RCP Σ	RCP AZ	RCP EL	LCP Σ	LCP AZ	LCP EL	Limit
2100	1.03	–	–	1.08	–	–	1.10
2110	1.06	–	–	1.03	–	–	1.10
2120	1.08	–	–	1.01	–	–	1.10
2270	1.097	–	–	1.095	–	–	1.10
2280	–	1.08	1.09		1.13	1.12	1.20
2285	1.01	–	–	1.09	–	–	1.10
2290	–	1.12	1.07	–	1.09	1.05	1.20
2300	1.098	–	–	1.095	–	–	1.10
2300	–	1.14	1.16	–	1.13	1.19	1.20

4.2.4 Data Sheet

Unit: SCM-30 Feed Assy

Serial No.: 1

Date: 6-3-65

Test Personnel: W. A. Leeper

	RCP Σ	RCP AZ	RCP EL	RCP X	LCP Σ	LCP AZ	LCP EL	LCP X	FREQ Mc
RCP Σ	O	48.4	38.1	32.3	38.9	56.4	31.4	40.2	2270
		47.	42.1	32.5	38.0	54.5	52.6	42.1	2285
		47.6	48.1	31.6	28.4	47.6	34.6	42.6	2300
RCP AZ	R	O	31.1	41.	55.4	14.4	30.5	42.9	2270
			44.9	54.5	57.5	15.8	31.1	48.5	2285
			43.1	38.7	47.4	17.0	31.4	55.6	2300
RCP EL	R	R	O	48.7	47.4	28.6	14.6	41.8	2270
				53.5	50.5	29.4	15.8	45.5	2285
				49.9	54.6	29.3	17.4	48.6	2300
RCP X	R	R	R	O	47.9	51.4	44.4	NA	2270
					46.5	50.	43.5		2285
					48.6	41.1	45.6		2300
LCP Σ	R	R	R	R	O	41.8	45.9	47.4	2270
						40.2	44.	45.0	2285
						38.8	41.	36.6	2300
LCP AZ	R	R	R	R	R	O	30.1	45.4	2270
							32.9	37.5	2285
							36.6	37.1	2300
LCP EL	R	R	R	R	R	R	O	37.4	2270
								36.5	2285
								38.6	2300
RCP Σ	O	30.1	36.5	31.1	28.6	38.9	40.6	33.4	2100
		53.4	28.3	31.6	33.4	49.9	35.4	35.4	2110
		56.7	30.1	32.7	29.9	48.7	37.9	38.5	2120
LCP Σ	R	46.6	41.2	35.2	O	40.4	51.6	32.9	2100
		48.4	37.1	38.3		37.1	42.9	32.4	2110
		48.7	40.3	42.5		40.1	42.2	32.4	2120

R = reciprocal reading

4.3.4 Data Sheet

Unit: SCM-30 Feed Assy
Serial No.: 1
Date: 6-7-65
Test Personnel: W. A. Leeper

Frequency - 2285

Polarization	RCP AZ	RCP EL	LCP AZ	LCP EL
H ↑	5.89	5.89	5.40	5.28
45^{o} ↗	5.67	5.47	5.57	5.58
E →	5.52	5.38	5.58	5.80
-45^{o} ↖	5.62	5.78	5.41	5.38

	Roll Error
RCP AZ	0.37
RCP EL	0.51
LCP AZ	0.18
LCP EL	0.52

4.4.4 Data Sheet

Unit: SCM-30 Feed Assy
Serial No.: 1
Date: 6-7-65
Test Personnel: W. A. Leeper

Null Plane Data*

RCP				LCP			
AZ Channel		EL Channel		AZ Channel		EL Channel	
AZ	EL	AZ	EL	AZ	EL	AZ	EL
0.86	3	3	6.00	0.30	3	3	5.64
0.67	4	2	5.88	0.38	4	2	5.70
0.55	5	1	5.79	0.45	5	1	5.80
0.41	6	0	5.75	0.55	6	0	5.95
0.39	7	9	5.70	0.69	7	9	6.12
0.30	8	8	5.68	0.80	8	8	6.28
0.24	9	7	5.54	0.90	9	7	6.40

* This data is plotted on rectangular graph paper.

4.4.4 Data Sheet (Continued)

Unit: SCM-30 Feed Assy
Serial No.: 1
Date: 6-7-65
Test Personnel: W. A. Leeper

Null Plane Orthogonality

	Angle Between Null Planes	Limit
RCP Error Channels	91.5°	$90 \pm 2^{\circ}$
LCP Error Channels	91.5°	

RCP to LCP Null Plane Comparison

	Angle Between Null Planes	Limit
RCP to LCP	10°	$\leq 10^{\circ}$

Boresight Agreement of RCP to LCP

RCP to LCP Indicated Boresight Agreement	$.15^{\circ}$

4.5.4 Data Sheet

Unit: SCM-30 Feed Assy

Serial No.: 1

Date: 6-8-65

Test Personnel: W. A. Leeper

Freq.	Ellipticity						Limit (db)
	RCP Σ	RCP AZ	RCP EL	LCP	LCP AZ	LCP EL	
2100	1.0*	--	--	1.2*	--	--	1.0
2110	0.9*	--	--	1.0*	--	--	1.0
2120	0.8*	--	--	1.0*	--	--	1.0
2270	0.3	--	--	0.5	--	--	1.0
2285	0.4	--	--	0.6	--	--	1.0
2290	--	0.8	1.8*	--	1.0	1.4	2.0
2300	0.6	--	--	0.3	--	--	1.0

* Meter read

4.6.4 Data Sheet

Unit: SCM-30 Feed Assy

Serial No.: 1

Date: 6-9-65

Test Personnel: W. A. Leeper

Freq. (Mc)	Null Depth				Limit (db)
	RCP AZ	RCP EL	ICP AZ	LCP EL	
2280	35.0	35.2	36.2	38.0	≥ 30
2290	37.2	36.0	38.3	36.6	≥ 30
2300	37.2	37.4	38.0	36.5	≥ 30

4.7.4 Data Sheet

Unit: SCM-30 Feed Assy

Serial No.: 1

Date: 6-9-65

Test Personnel: W. A. Leeper

Hyperboloid Edge Taper

Freq.	Taper RCPΣ	Taper LCPΣ	Limit (db)
2270	11.8	11.8	11 ±1
2285	11.7	11.8	
2300	12.0	12.0	

Sidelobe Level

Freq.	Sidelobe Level RCPΣ	Sidelobe Level LCPΣ	Limit (db)
2270	27.8	27.8	≥ 20
2285	27.6	27.0	
2300	28.4	28.4	

Efficiency

Plane	Integrated Efficiency (%)
Azimuth	87.3%
Elevation	87.3%
+45	87.4%
-45	87.4%
Average	87.35%

The fraction of input power contained within the 11.0 db beamwidth is 87.35% at 2295.

4.7.4 Data Sheet (Continued)

Peak-to-peak Separation

Freq.	Peak-to-peak Separations				Limit (deg)
	RCP AZ	RCP EL	LCP AZ	LCP EL	
2280	35.0	35.2	36.2	38.0	
2290	37.2	36.0	38.3	36.6	38
2300	37.2	37.4	38.0	36.5	

Sum-to-Error Channel Peak

Freq. (Mc)	RCP Channels		LCP Channels		Limit (db)
	Σ-AZ	Σ-EL	Σ-AZ	Σ-EL	
2290	2.2	2.2	2.3	2.5	0 - 4

4.9.4 Data Sheet

Unit: SCM-30 Feed Assy

Serial No.: 1

Date: 6/2/65

Test Personnel: W. A. Leeper

Freq.	Two Way Loss	One Way Loss
2105	0.06	0.03
2285	0.09	0.045

III-C DSIF S-BAND CASSEGRAIN
MONOPULSE FEED
DATA SHEETS
SERIAL No. 2

4.1.4 Data Sheet

Unit: 9431332

Serial No.: 2

Date: 8-6-65

Test Personnel: W. A. Leeper

Freq. (Mc)	VSWR						Limit
	RCP Σ	RCP AZ	RCP EL	LCP Σ	LCP AZ	LCP EL	
2100	1.08	--	--	1.08	--	--	1.10
2110	1.02	--	--	1.07	--	--	1.10
2120	1.03	--	--	1.09	--	--	1.10
2270	1.09	--	--	1.10	--	--	1.10
2280	--	1.07	1.09	--	1.08	1.14	1.20
2285	1.06	--	--	1.09	--	--	1.10
2290	--	1.12	1.09	--	1.04	1.10	1.20
2300	1.07	--	--	1.10	--	--	1.10
2300	--	1.04	1.15	--	1.07	1.08	1.20

4.2.4 Data Sheet

Unit: 9431332

Serial No.: 2

Date: 8-6-65

Test Personnel: W. A. Leeper

	RCP Σ	RCP AZ	RCP EL	RCP X	LCP Σ	LCP AZ	LCP EL	LCP X	FREQ Mc
RCP Σ	O	47.4	44.4	42.4	31	47.9	47.4	39.4	2270
		48.5	41.5	40.9	43.5	47.5	47.5	39	2285
		46.6	39.1	33.3	34.6	48.6	46.1	39.1	2300
RCP AZ	R	O	33.8	35.4	50.4	14.1	35	33.3	2270
			36.2	39.1	50.5	15.4	34.2	34.9	2285
			37.6	47.1	48.6	16.3	34.1	35.6	2300
RCP EL	R	R	O	40.8	45.4	29.4	14.0	37.9	2270
				42.5	44.5	29.8	15.5	37.5	2285
				40.1	43.1	29.7	16.4	42.1	2300
RCP X	R	R	R	O	38.9	49.4	48.4		2270
					39.7	42.5	48.5	NA	2285
					39.6	42.6	49.1		2300
LCP Σ	R	R	R	R	O	45.4	38.4	39.9	2270
						43.5	36.5	44	2285
						45.1	37	47.6	2300
LCP AZ	R	R	R	R	R	O	29.5	36.9	2270
							32.7	34	2285
							36.2	34.1	2300
LCP EL	R	R	R	R	R	R	O	45.4	2270
								46.5	2285
								41.6	2300
RCP Σ	O	47.4	46.4	32.6	28.6	41.7	44.7	33.4	2100
		45.7	34	31.9	31.2	39.7	41	33.2	2110
		49	35.8	32.7	28.5	35.5	43	42	2120
LCP Σ	R	47.4	40.9	34.9	O	47.9	46.9	32.3	2100
		46.2	37.2	40		43.7	42.7	33.2	2110
		47	41.3	46		47	44.5	32.5	2120

R = reciprocal reading

4.3.4 Data Sheet

Unit: 9431332

Serial No.: 2

Date: 8-4-65

Test Personnel: W. A. Leeper

Frequency – 2290

Polarization	RCP AZ	RCP EL	LCP AZ	LCP EL
H ↑	4.68	5.08	4.55	4.70
45° ↗	4.64	4.88	4.40	4.80
E →	4.50	4.85	4.54	4.88
-45° ↖	4.50	5.00	4.50	4.80

	Roll Error
RCP AZ	.18
RCP EL	.23
LCP AZ	.15
LCP EL	.18

4.4.4 Data Sheet

Unit: 9431332

Serial No.: 2

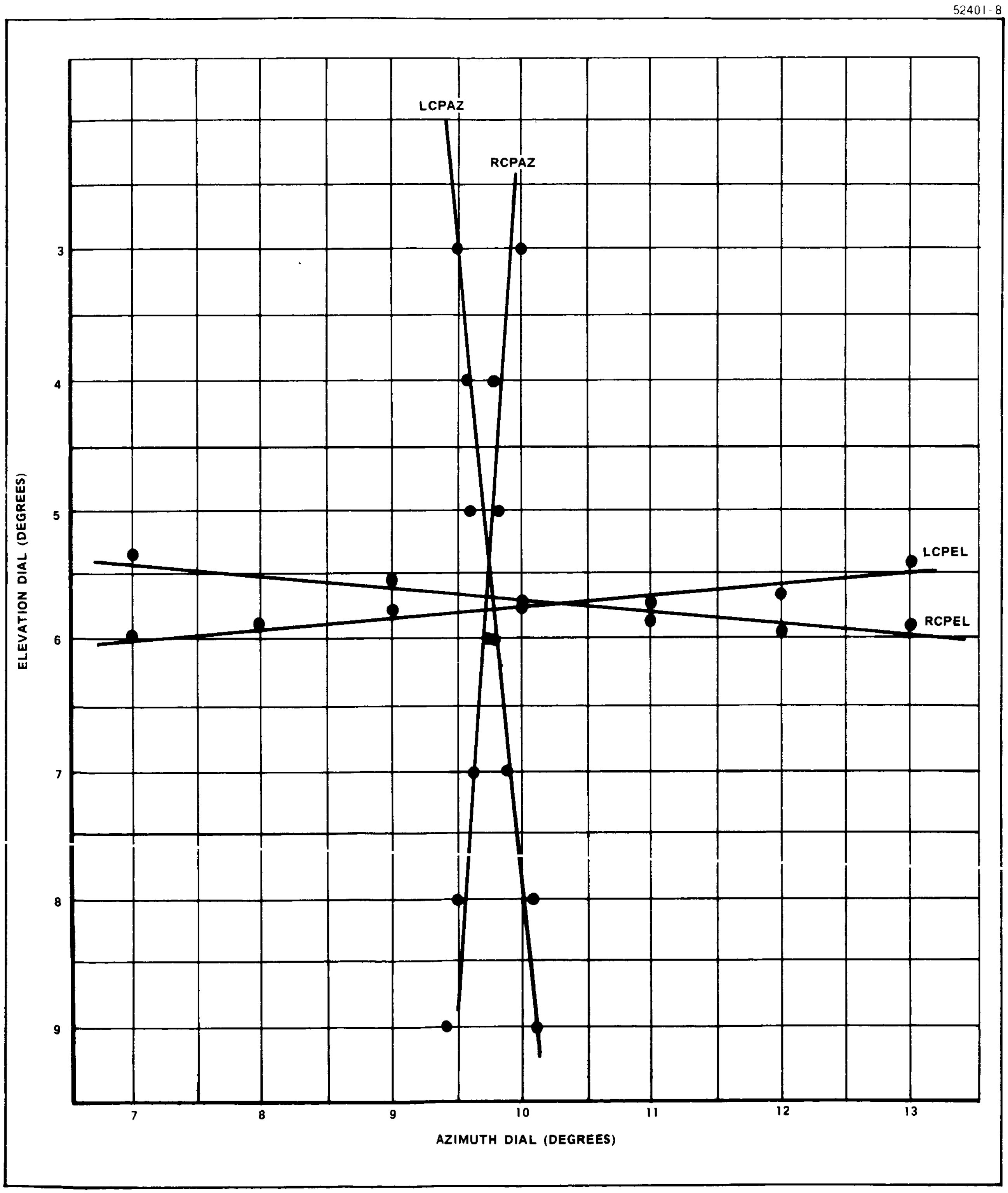
Date: 8-3-65

Test Personnel: W. A. Leeper

Null Plane Data*

RCP				LCP			
AZ Channel		EL Channel		AZ Channel		EL Channel	
AZ	EL	AZ	EL	AZ	EL	AZ	EL
10.0	3	7	5.40	9.50	3	7	6.0
9.85	4	8	5.50	9.58	4	8	5.90
9.80	5	9	5.55	9.65	5	9	5.80
9.75	6	10	5.70	9.80	6	10	5.75
9.65	7	11	5.80	9.90	7	11	5.70
9.50	8	12	5.90	10.04	8	12	5.60
9.40	9	13	5.95	10.1	9	13	5.40

*This data is plotted on rectangular graph paper.



52401-8
LCPAZ
RCPAZ
LCPEL
RCPEL
ELEVATION DIAL (DEGREES)
3
4
5
6
7
8
9
AZIMUTH DIAL (DEGREES)
7
8
9
10
11
12
13

4.4.4 Data Sheet (Continued)

Unit: 9431332

Serial No.: 2

Date: 8-3-65

Test Personnel: W. A. Leeper

Null Plane Orthogonality

	Angle Between Null Planes	Limit
RCP Error Channels	89^{o}	90 ± 2^{o}
LCP Error Channels	89.4^{o}	

RCP to LCP Null Plane Comparison

	Angle Between Null Planes	Limit
RCP to LCP	9.5^{o}	$\leq 10^{o}$

Boresight Agreement of RCP to LCP

RCP to LCP Indicated Boresight Agreement	0.12^{o}

4.5.4 Data Sheet

Unit: 9431332

Serial No.: 2

Date: 8-3-65

Test Personnel: W. A. Leeper

Freq.	Ellipticity						Limit (db)
	RCP Σ	RCP AZ	RCP EL	LCP Σ	LCP AZ	LCP EL	
2100	0.65	--	--	0.75	--	--	1.0
2110	0.8	--	--	0.6	--	--	1.0
2120	0.7	--	--	0.6	--	--	1.0
2270	0.6	--	--	0.6	--	--	1.0
2285	0.6	--	--	0.75	--	--	1.0
2290	--	1.4	1.9	--	1.7	1.3	2.0
2300	0.7	--	--	0.75	--	--	1.0

4.6.4 Data Sheet

Unit: 9431332

Serial No.: 2

Date: 8-6-65

Test Personnel: W. A. Leeper

Freq. (Mc)	Null Depth				Limit (db)
	RCP AZ	RCP EL	LCP AZ	LCP EL	
2280	35.6	38+	37+	38+	≥ 30
2290	35.0	38+	38+	38+	≥ 30
2300	35.2	38+	38+	38+	≥ 30

4.7.4 Data Sheet

Unit: 9431332

Serial No.: 2

Date: 8-6-65

Test Personnel: W. A. Leeper

Hyperboloid Edge Taper

Freq.	Taper RCP Σ	Taper LCP Σ	Limit (db)
2270	11.9	11.6	11 ± 1
2285	11.9	11.6	
2300	11.9	11.8	

Sidelobe Level

Freq.	Sidelobe Level RCP Σ	Sidelobe Level LCP Σ	Limit (db)
2270	27.5	28.7	≥ 20
2285	27.3	27.4	
2300	26.8	28.4	

Efficiency

Plane	Integrated Efficiency (%)
Azimuth	85.9
Elevation	86.9
+ 45	89.2
-45	89.2
Average	87.8

The fraction of input power contained within the 11.0 db beamwidth is 87.8% at 2295.

4.7.4 Data Sheet (Continued)

Peak-to-peak Separation

Freq.	Peak-to-peak Separations				Limit (deg)
	RCP AZ	RCP EL	LCP AZ	LCP EL	
2280	38	37.5	38	38.0	38
2290	37.5	37	37	37.0	
2300	37	37	37	36.5	

Sum-to-Error Channel Peak

Freq. (Mc)	RCP Channels		LCP Channels		Limit (db)
	Σ− AZ	Σ − EL	Σ − AZ	Σ − EL	
2290	2.5	2.5	2.1	2.4	0-4

4.9.4 Data Sheet

Unit: 9431332

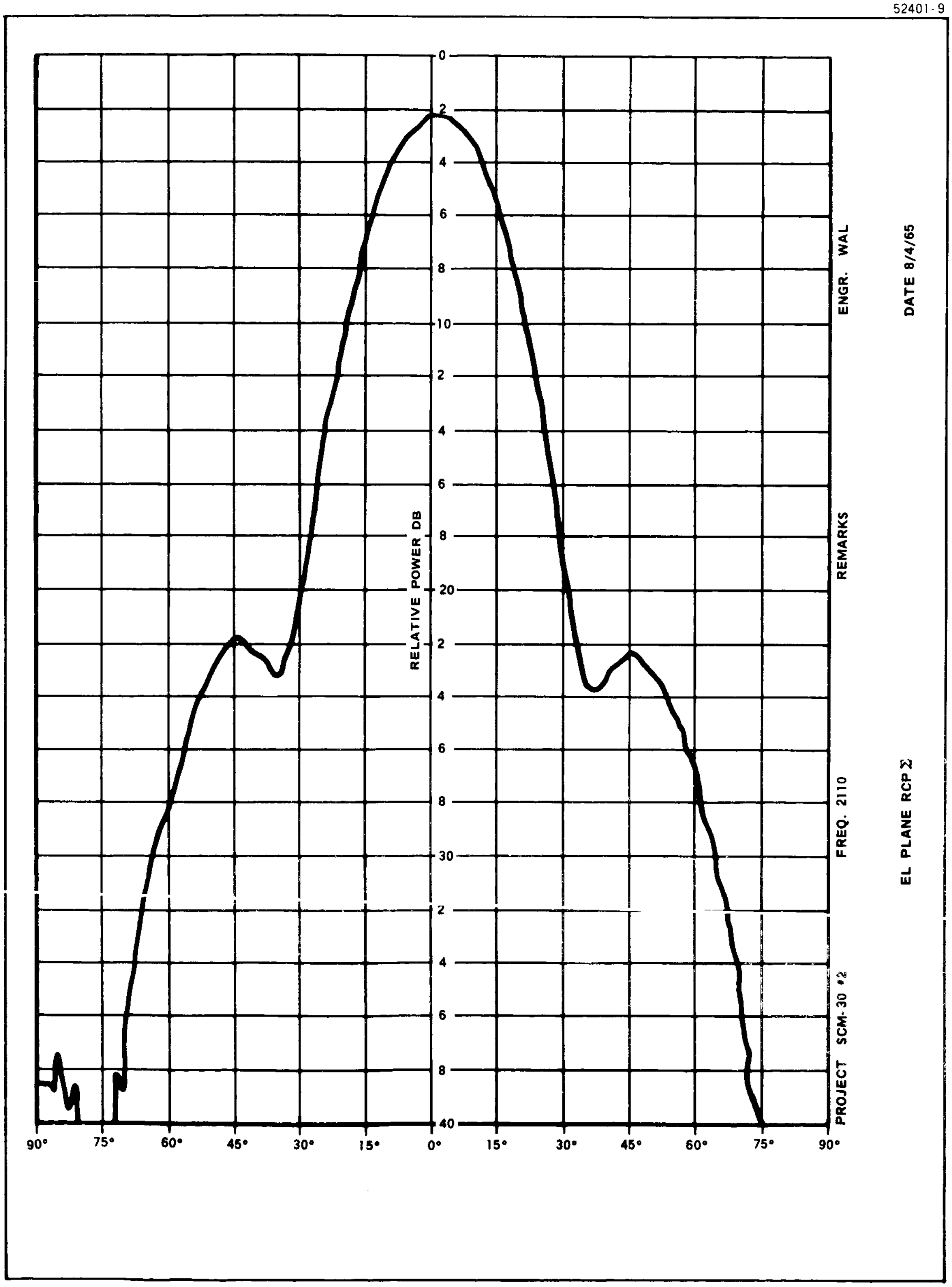
Serial No.: 2

Date: 8-9-65

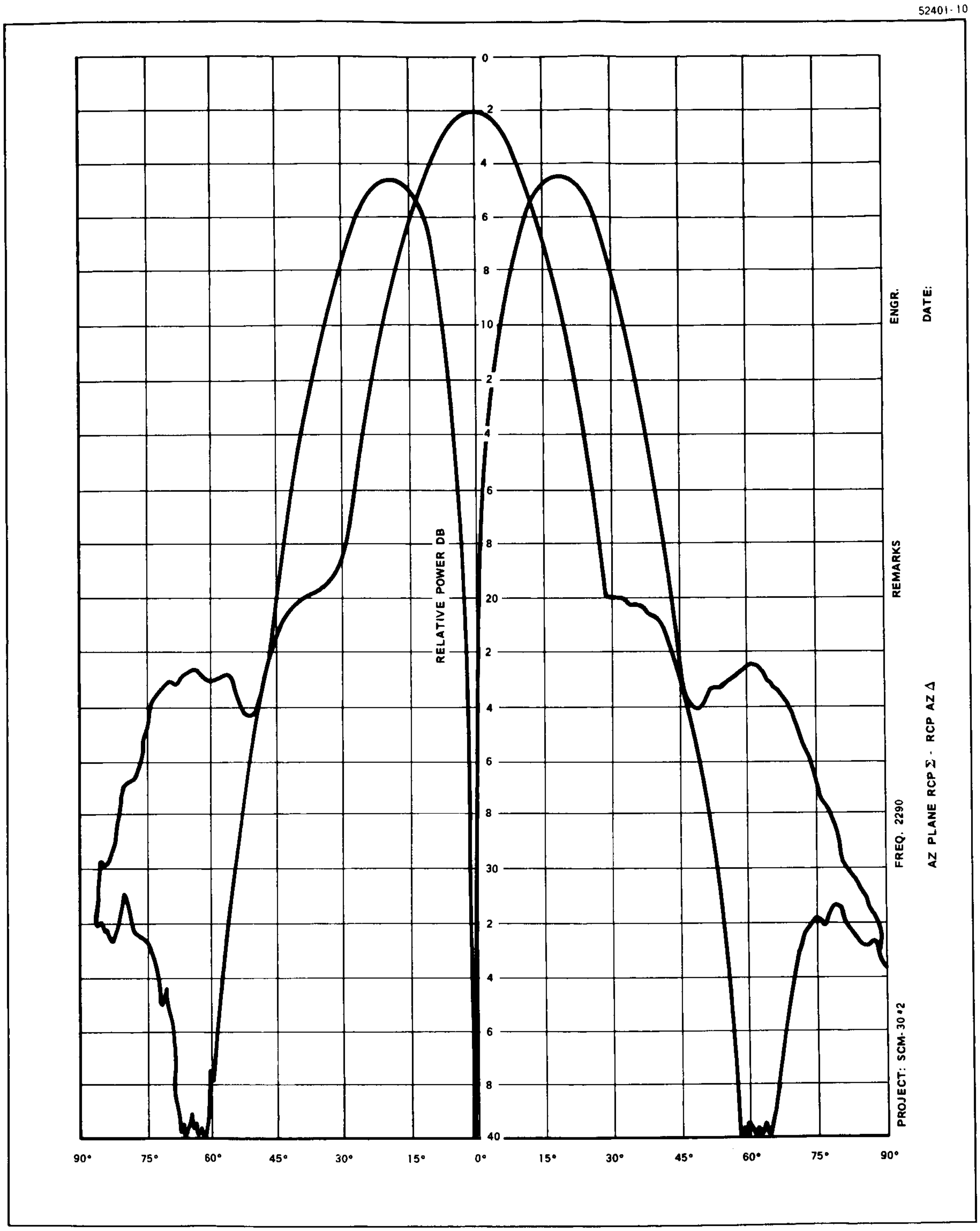
Test Personnel: W. A. Leeper

Freq.	Two Way Loss	One Way Loss
2105	.16	.08
2285	.14	.07

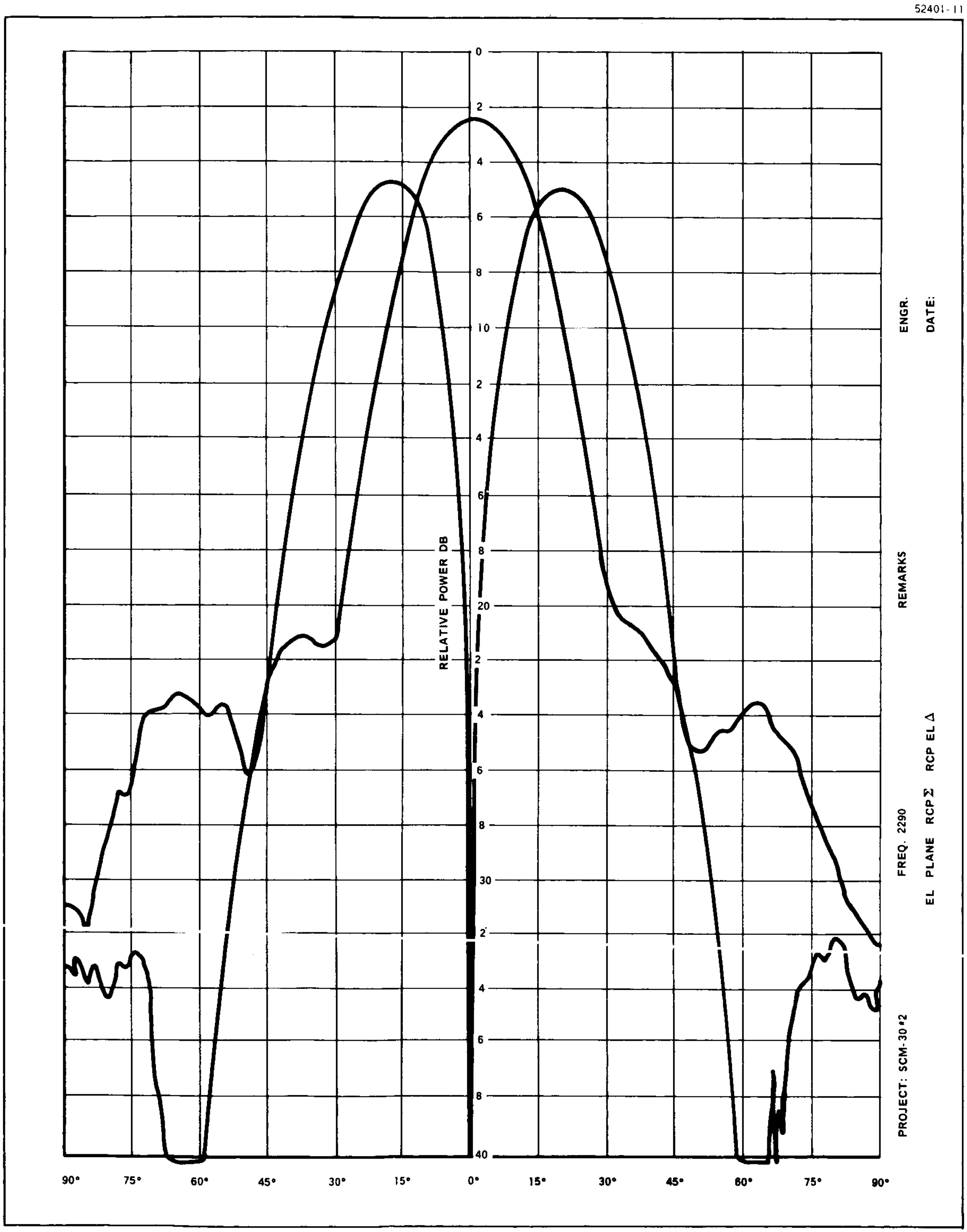
III-D DSIF S-Band
CASSEGRAIN MONOPULSE FEED
TYPICAL PATTERNS



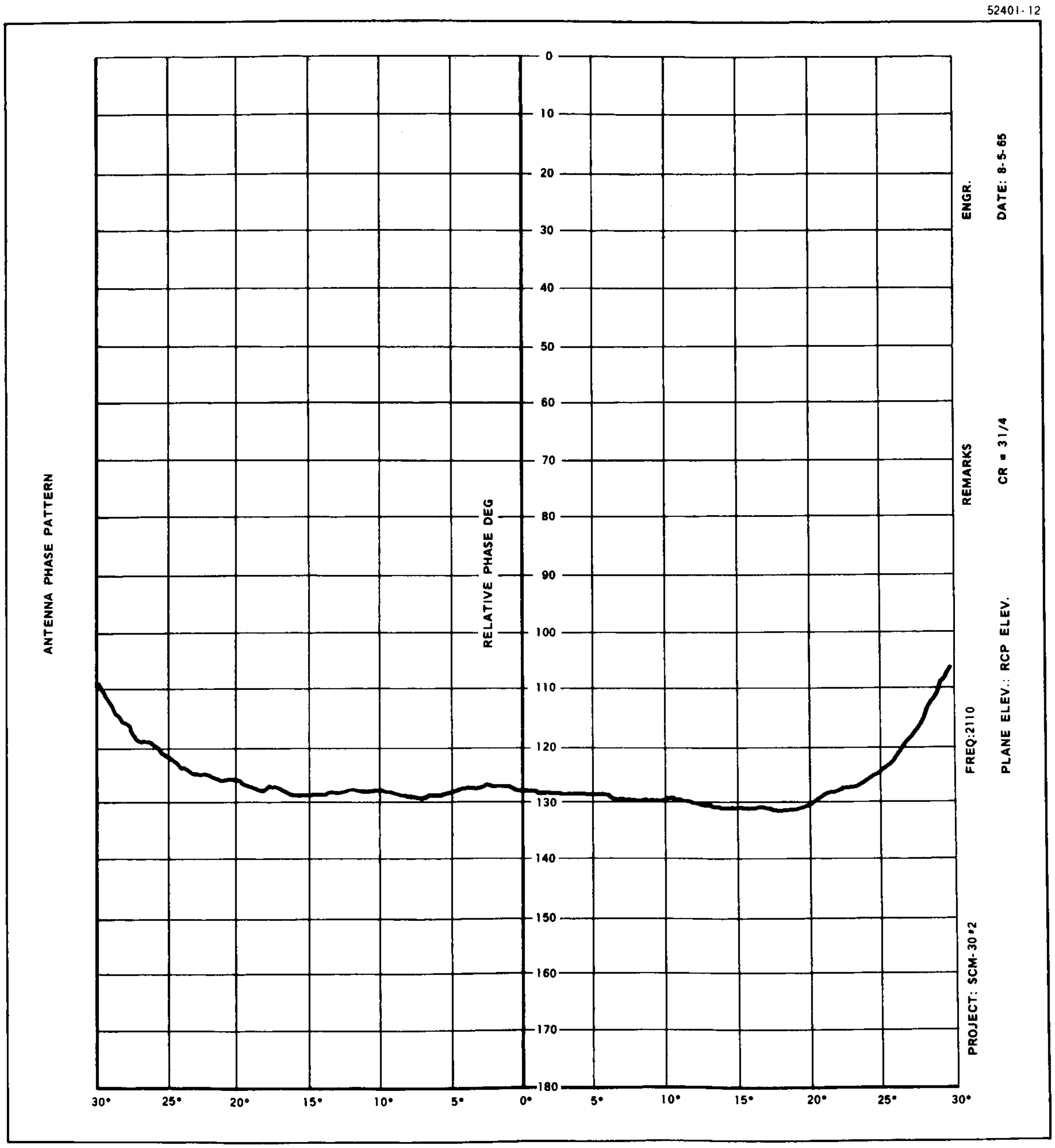
Antenna Pattern #1



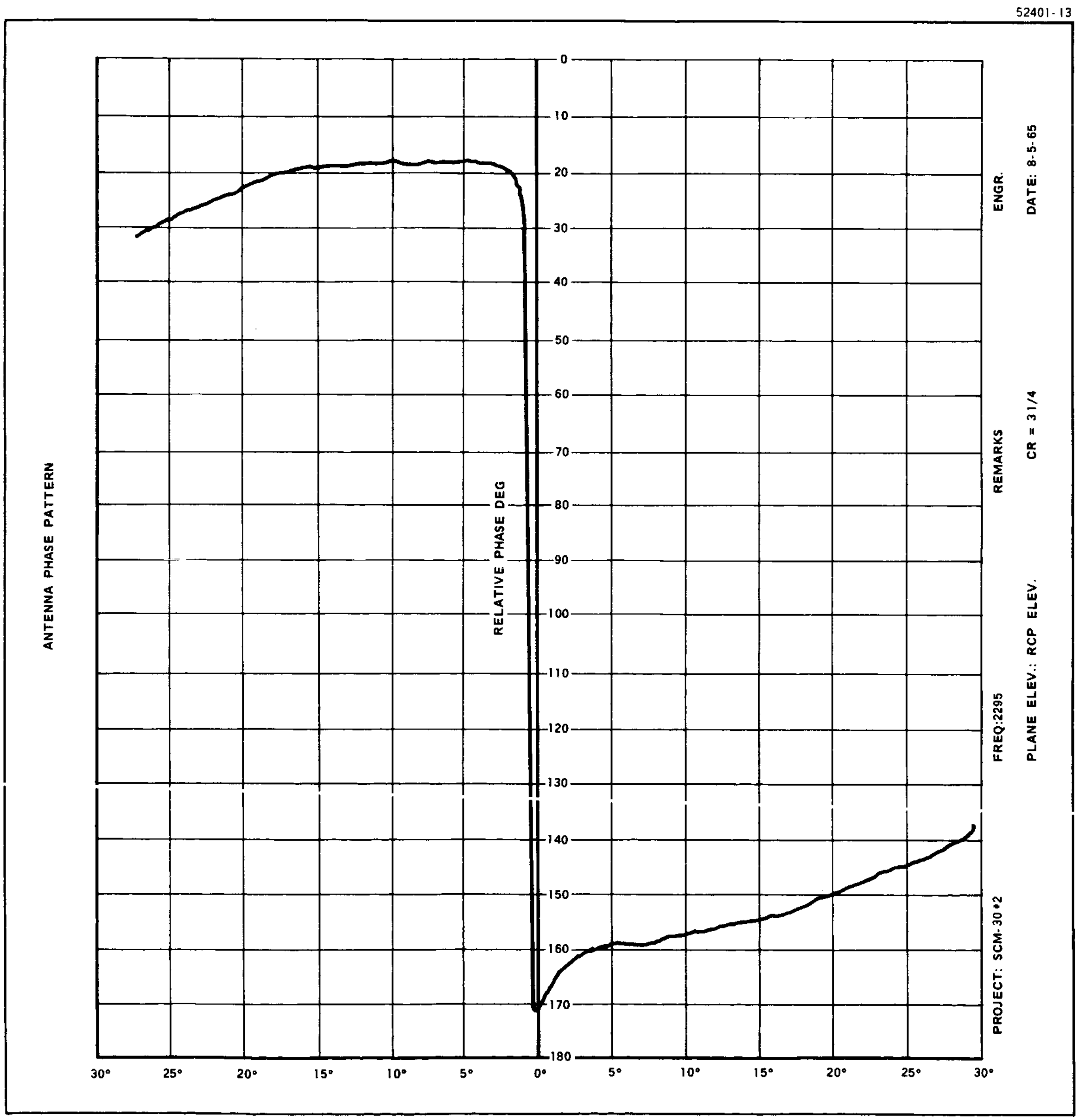
Antenna Pattern #2



Antenna Pattern #3



Antenna Pattern #4



Antenna Pattern #5

Appendix IV

ELECTRICAL PROCEDURES AND TEST DATA

IV-A ELECTRICAL PROCEDURES AND TEST DATA S-BAND CASSEGRAIN MONOPULSE CONE ASSEMBLY (30-FOOT ANTENNA)

Appendix Four

1. SCOPE

This acceptance test document covers the tests required to verify the electrical performance of the S-Band Cassegrain Monopulse (SCM) Cone Assembly.

2. APPLICABLE DOCUMENTS

Drawings

Jet Propulsion Laboratory

9431329	Cone Assembly Layout
9431332	Feed Assembly

Specifications

Jet Propulsion Laboratory

DOM-1112-DSN	Design Specification, DSIF S-Band Cassegrain Monopulse Feed
DOM-1115-DSN	Design Specification, DSIF S-Band Cassegrain Monpulse Cone Assembly

Other Publications

Microwave Measurements, Edward L. Ginztor, McGraw-Hill Book Company, Inc., New York, 1957.

Techniques of Microwave Measurements, Carol G. Montgomery, McGraw-Hill Book Company, Inc., New York, 1947.

Making Microwave Measurements, Pat Tuciarone, Electronic Industries, June 1962.

3. TEST PREPARATIONS

3.1 Test Equipment – The following test equipment, or equivalent, shall be provided:

			Quantity
(a)	RF Generator	HP 616 B	1
(b)	Square Wave Generator	HP 211 A	1
(c)	Low Pass Filter	μ Lab LA 30 N	1
(d)	Isolator	Sperry D44L 43-25	1
(e)	Frequency Meter	FXR N 410 A	1
(f)	Slotted Line	Narda 225 B	1
(g)	Tunable Probe	Sperry 28 B1	1
(h)	Bolometer	Narda 610 B	2
(i)	SWI	HP 415 B	2
(j)	Coax-Waveguide Adapter	Narda 615	2
(k)	Waveguide Detector	Narda 535	1
(l)	Directional Coupler	10 and 20 db	2

3.2 Test Conditions

3.2.1 Environment – Unless specified herein, all tests shall be performed under existing ambient temperature, atmospheric pressure and humidity.

3.2.2 Equipment Warmup – Equipment shall be permitted a warmup period of 15 minutes before any of the acceptance tests are performed.

3.2.3 Calibration – Test equipment used to conduct tests in this document shall be calibrated at such intervals as are necessary to insure maintenance of the accuracies required. Evidence of calibration shall be attached to each instrument together with the next calibration due date.

3.2.4 Equipment Setup – Tests shall be performed using the setups shown in Section 4.0.

3.2.5 Test Measurements – All tests shall be performed using standard measurement techniques or equivalent and shall be conducted in the manner described in Section 4.0.

3.2.6 Test Data – Test data shall be recorded in accordance with the DATA SHEET of Section 4.0. Copies of the test data shall be provided to the customer.

4. TEST PROCEDURE

4.1 VSWR

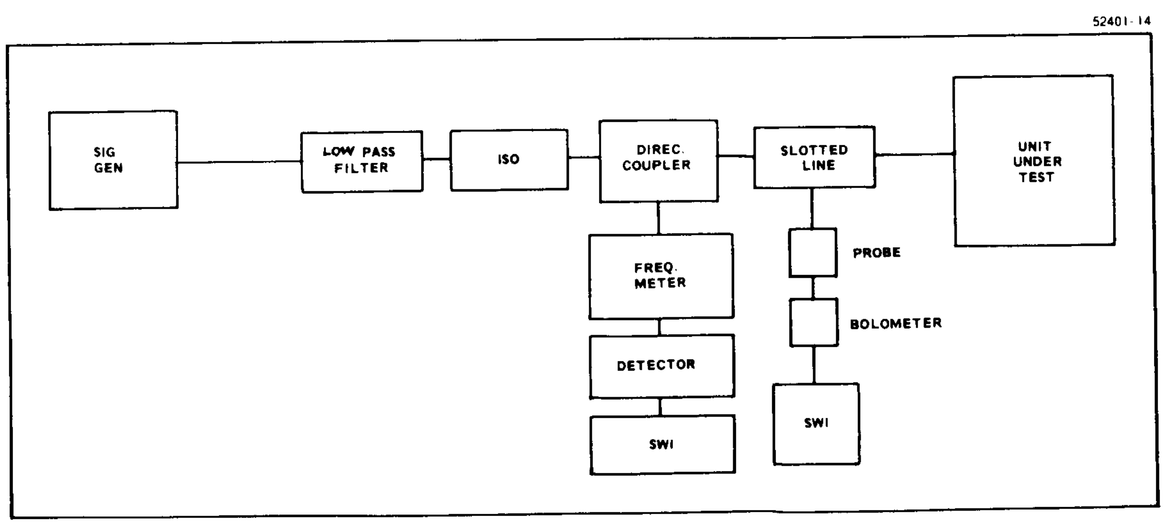
4.1.1 Requirements –

(1) The VSWR of the sum channel in either the LCP or RCP mode shall not exceed 1.10 at 2110 ± 10 Mc and 2285 ± 15 Mc.

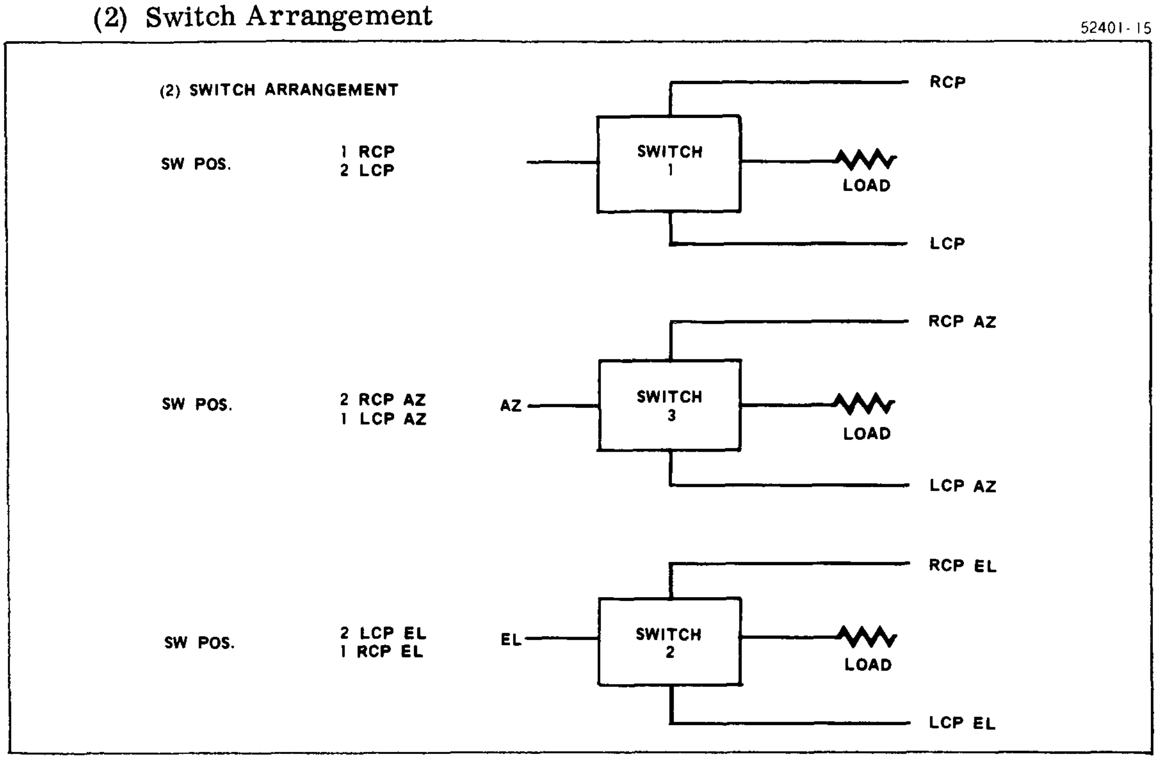
(2) The VSWR of each error channel in either the LCP or RCP mode shall not exceed 1.30 at 2290 ± 10 Mc.

4.1.2 Test Setup

(1) Test Equipment Setup



(2) Switch Arrangement



4.1.3 Measurements

(1) Connect the sum channel port of the unit under test into the setup as shown

(2) Measure the VSWR of the port in both LCP and RCP modes at the appropriate frequencies

(3) Connect the azimuth channel port of the unit under test into the setup as shown and repeat step (2)

4.1.4 Data Sheet

Unit ____________

Serial No. ____________

Date ____________

Test Personnel ____________

Sum Channel VSWR

Freq. Mc	VSWR RCP Σ	VSWR LCP Σ	Limit
2100			1.10
2110			1.10
2120			1.10
2270			1.10
2285			1.10
2300			1.10

Error Channel VSWR

Freq. Mc	VSWR				Limit
	RCP AZ	RCP EL	LCP AZ	LCP EL	
2280					1.30
2290					1.30
2300					1.30

4.2 Isolation

4.2.1 Requirements

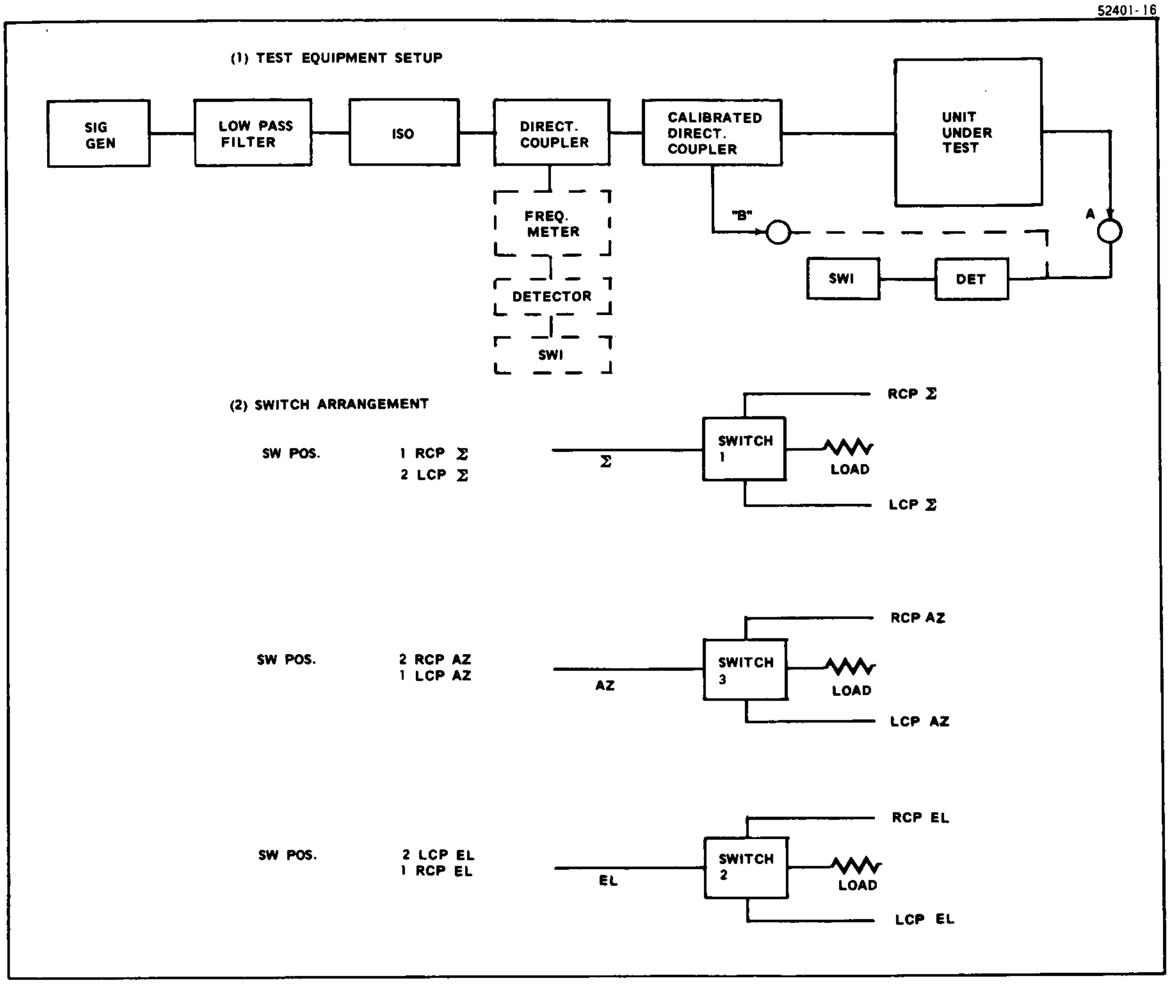
(1) The isolation between each sum port and the remaining seven ports shall exceed 30 db at 2100 ± 10 Mc and 2285 ± 15 Mc

(2) The isolation between the LCP and RCP error channel of the same plane shall exceed 15 db at 2285 ± 15 Mc

(3) All other isolations shall exceed 20 db at 2285 ± 15 Mc

4.2.2 Test Setup

(1) Test Equipment Setup



4.2.3 Measurements

(1) With the detector connected to test point B, set a reference level on the SWI.

(2) Connect the detector to test point A and note the signal level on the SWI.

(3) The isolation is equal to the difference between the reference level in Step (1) and the signal level in Step (2), plus calibrated coupling value (~20 db).

(4) Change test point A to each of the remaining ports, and repeat steps (2) and (3).

4.2.4 Data Sheet *

Unit: ____________________

Serial No.: ____________________

Date: ____________________

Test Personnel: ____________________

	RCP Σ	RCP AZ	RCP EL	LCP Σ	LCP AZ	LCP EL	FREQ. Mc
RCP Σ	X			NM			2110
				NM			2285
RCP AZ	R	X			NM		2285
RCP EL	R	R	X			NM	2285
LCP Σ	R	R	R	X			2110
							2285
LCP AZ	R	R	R	R	X		2285
LCP EL	R	R	R	R	R	R	2285

R = reciprocal reading
NM = not measured*

* Complete isolation measurements were conducted on the feed at a unit level. At the cone assembly level, only a portion of these measurements can be repeated without partial disassembly of the waveguide circuitry. For these reasons, only a partial check of isolations are repeated at this level to assure that the cone has been properly assembled.

IV-B DSIF S-BAND CASSEGRAIN
MONOPULSE CONE ASSEMBLY
DATA SHEETS
SERIAL NO. 1

4.1.4 Data Sheet

Unit 9431331

Serial No. 1

Date 7-8-65

Test Personnel W. A. Leeper

Sum Channel VSWR

Freq. Mc	VSWR		Limit
	RCP Σ	LCP Σ	
2100	1.09	1.09	1.10
2110	1.06	1.08	1.10
2120	1.01	1.04	1.10
2270	1.05	1.16*	1.10
2285	1.03	1.12*	1.10
2300	1.13*	1.09	1.10

Error Channel VSWR

Freq. Mc	VSWR				Limit
	RCP AZ	RCP EL	LCP AZ	LCP EL	
2280	1.07	1.05	1.12	1.08	1.30
2290	1.16	1.10	1.12	1.10	1.30
2300	1.14	1.16	1.18	1.11	1.30

* Disposition to be made by JPL Engineering

4.2.4 Data Sheet *

Unit: 9431551

Serial No.: 1

Date: 7-8-65

Test Personnel: W.A. Leeper

	RCP Σ	RCP AZ	RCP EL	LCP Σ	LCP AZ	LCP EL	FREQ. Mc
RCP Σ	X	50.7	28.7**	NM	48.7	33.7	2110
		48.5	43.3	NM	51.5	48.5	2285
RCP AZ	R	X	36.7	44	NM	29.5	2285
RCP EL	R	R	X	47	27.5	NM	2285
LCP Σ	R	R	R	X	37.7	40.7	2110
					42.5	41.7	2285
LCP AZ	R	R	R	R	X	35	2285
LCP EL	R	R	R	R	R	X	2285

R = reciprocal reading
NM = not measured*

* Complete isolation measurements were conducted on the feed at a unit level. At the cone assembly level, only a portion of these measurements can be repeated without partial disassembly of the waveguide circuitry. For these reasons, only a partial check of isolations are repeated at this level to assure that the cone has been properly assembled.

** Disposition to be made by JPL Engineering

IV-C DSIF S-BAND CASSEGRAIN
MONOPULSE CONE ASSEMBLY
DATA SHEETS
SERIAL NO. 2

4.1.4 Data Sheet

Unit Scm-30 Cone Assy

Serial No. 2

Date 9-10-65

Test Personnel Leeper

Sum Channel VSWR

Freq. Mc	VSWR		Limit
	RCP Σ	LCP Σ	
2100	1.10	1.06	1.10
2110	1.07	1.03	1.10
2120	1.02	1.05	1.10
2270	1.08	1.12*	1.10
2285	1.06	1.09	1.10
2300	1.04	1.09	1.10

Error Channel VSWR

Freq. Mc	VSWR				Limit
	RCP AZ	RCP EL	LCP AZ	LCP EL	
2280	1.05	1.08	1.12	1.12	1.30
2290	1.14	1.10	1.07	1.15	1.30
2300	1.09	1.16	1.12	1.01	1.30

* Out of tolerance

4.2.4 Data Sheet *

Unit: Scm-30 Cone Assy

Serial No.: 2

Date: 9-10-65

Test Personnel: Leeper

	RCP Σ	RCP AZ	RCP EL	LCP Σ	LCP AZ	LCP EL	FREQ. Mc
RCP Σ	X	45.7	35.7	NM	48.7	39.5	2110
		47.0	42.7	NM	47.5	48.5	2285
RCP AZ	R	X	38.0	46.5	NM	34.0	2285
RCP EL	R	R	X	47.0	30.2	NM	2285
LCP Σ	R	46.2	38.9	X	41.7	42.2	2110
		R	R		46.5	37.0	2285
LCP AZ	R	R	R	R	X	33.2	2285
LCP EL	R	R	R	R	R	X	2285

R = reciprocal reading
NM = not measured*

* Complete isolation measurements were conducted on the feed at a unit level. At the cone assembly level, only a portion of these measurements can be repeated without partial disassembly of the waveguide circuitry. For these reasons, only a partial check of isolations are repeated at this level to assure that the cone has been properly assembled.

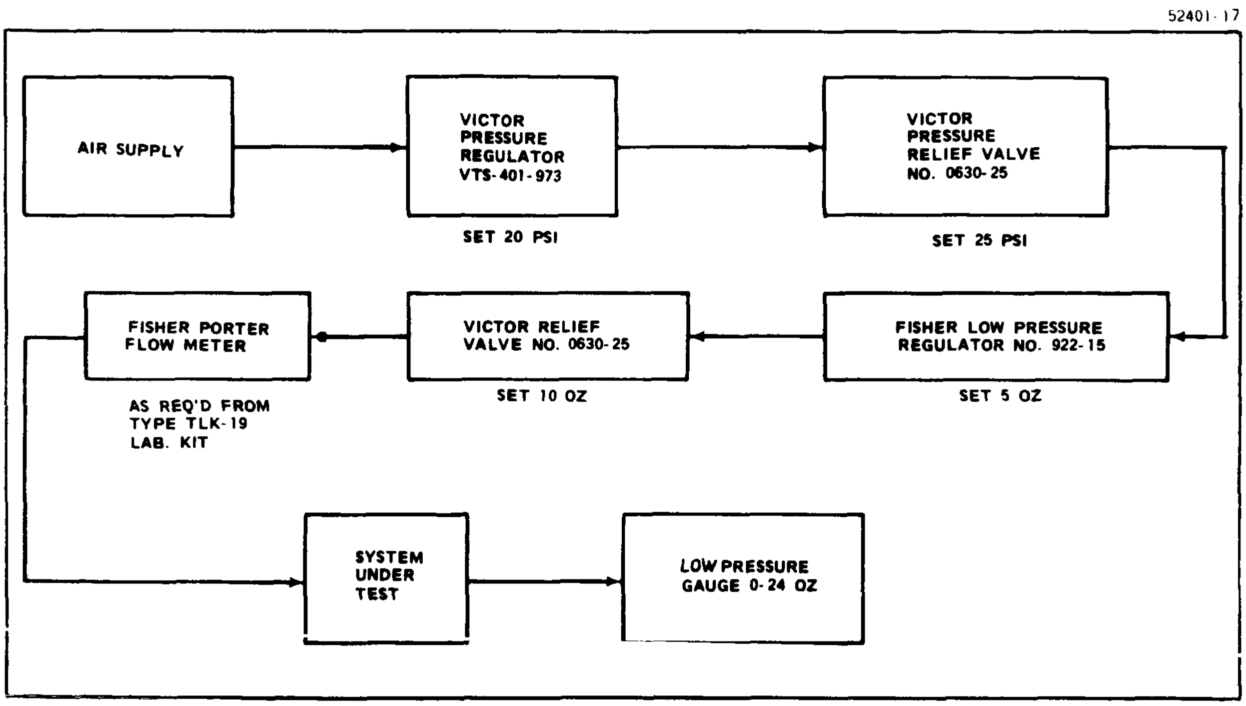
Appendix V
PRESSURE LEAK TEST

Appendix V

PRESSURE LEAK TEST

1.1 Requirement: The feed and the SCM-30 Cone Assembly shall be capable of withstanding pressures with dry nitrogen up to 0.3 psig.

Equipment and Setup:



Procedure

1. Connect the low pressure dry nitrogen supply to one of the H-bends of the Feed Adapter for the Feed Test, and to the terminal waveguide of the Output Transmission line for the SCM-30 Assembly test.

2. Connect the low pressure gauge to some other convenient port.

3. Set input pressure to 0.3 psig (5 oz) and allow the system to reach steady state.

4. Record the dry nitrogen flow rate and the system pressure.

Pressure Leak Test Data

The following pages are reproductions of the data sheets used in taking pressure leak test data on SCM-30 Feeds S.N. 1 and 2, and SCM-30 Cone Assemblies S.N. 1 and 2.

DATA SHEET

Unit: J9431332 Feed Assembly

Serial No.: 1

Date: 16 June 1965

Test Personnel: K. C. Carlson 10-56-40

Pressure: psig	Leakage: $^{cc}/min$	Limit: $^{cc}/min$
0.3 PSI	50 $^{cc}/min$	Not Applicable

DATA SHEET

Unit: J9431332 Feed Assembly

Serial No.: 2

Date: 2 August 1965

Test Personnel: K. C. Carlson 10-56-40

Pressure: psig	Leakage: $^{cc}/min$	Limit: $^{cc}/min$
0.3 PSI	140 $^{cc}/min$	Not Applicable

DATA SHEET

Unit: J9431331 SCM-30 Cone Assy.

Serial No.: 2

Date: 17 September 65

Test Personnel:

Pressure: psig	Leakage: cc/min	Limit: cc/min
0.3	320.00	500

DATA SHEET

Unit: J9431331 SCM-30 Cone Assy.

Serial No.: 1

Date: 9 July 1965

Test Personnel: K. C. Carlson 10-56-40

Pressure: psig	Leakage: cc/min	Limit: cc/min
0.3	280.00	500